PHILOSOPHICAL

EXPERIMENTS.

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PHILOSOPHICAL EXPERIMENTS:

CONTAINING
Uſeful, and Neceſſary INSTRUCTIONS for ſuch
as undertake long Voyages at Sea.

Shewing how SEA-WATER may be made
FRESH and WHOLSOME: And how FRESH-
WATER may be preſerv'd Sweet.

How BISCUIT, CORN, &c. may be ſecured from
the Weevel, Meggots, and other Inſects.

And FLESH preſerv'd in hot Climates, by SALTING
ANIMALS whole.

To which is added,
An Account of ſeveral Experiments and Obſervations
on CHALYBEATE or STEEL-WATERS: With ſome
Attempts to convey them to diſtant Places, preſerving their Virtue to a greater Degree than has
hitherto been done.

Likewiſe a Propoſal for cleanſing away Mud, &c.
out of Rivers, Harbours, and Reſervoirs.

Which were read before the ROYAL-SOCIETY, at
ſeveral of their Meetings,

By *STEPHEN HALES*, D. D. F. R. S.
Rector of *Farringdon* in *Hampſhire*, and
Miniſter of *Teddington*, *Middleſex*.

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To which is added,

An Account of several Experiments and Observations on CHALYBEATE or STEEL-WATERS: With some Attempts to convey them to distant Places, preserving their Virtue to a greater Degree than has hitherto been done.

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G.R. III. BRITISH MUSEUM

(1)

To the Right Hon^ble the Lords Com^rs of the Admiralty.

THE following Treatise being intended chiefly for the Service of the Navy, I am naturally led to address my Self to Your Lordships

A

TO

*The Right Hon^ble^* *Sir* CHARLES
WAGER, *Kn^t^*
Sir THOMAS LYTTLETON, *Bar^t.^*
Sir THOMAS FRANCKLAND, *Bar^t.^*
THOMAS CLUTTERBUCK, *Eſq*;
The Right Hon^ble^ the Lord WILLIAM
POWLET.
JOHN CAMPBELL, *Eſq*;
The Right Hon^ble^ the Lord VERE
BEAUCLERK.

Lords Commiſſioners of the Admiralty.

MY LORDS,

THE following Treatiſe being intended chiefly for the uſe of Seafaring Perſons, I am naturally led to addreſs my ſelf to

those

thoſe who are at the Head of, and have the Direction and Tranſacting of the maritime Affairs of far the moſt numerous and Powerful Fleet in the World.

It was to ſome of Your Lordſhips to whom I had the Honour of firſt communicating my Intentions of engaging in theſe Reſearches, which you were pleaſed to encourage me to purſue: That we might, if poſſible, find a never-failing Spring of freſh Waters in the midſt of the *Ocean*.

I muſt confeſs I was at firſt much diſcouraged, when I reflected on my Raſhneſs, in venturing on an Undertaking, which had baffled the repeated Attempts of the ableſt Philoſophers and Chymiſts, both Ancient and Modern: In ſo much that they looked upon it as almoſt impracticable to find out any way to procure a wholeſome Drink from Sea-Water. In which yet I have ſucceeded far beyond what I could have expected; having found means not only to free diſtilled Sea-Water, from its nauſeous bitter Oily Bitumen; which made it moſt diſagreeable to drink; but alſo from another very hurtful Quality, *viz.* the Spirit of Bittern Salt, which is apt to ariſe in great plenty in Diſtillation; but is now happily found to be detained from riſing up by the ſame means, that the nauſeous bitter Oily Bitumen is prevented from riſing.

I hope alſo that the Method here propoſed to keep freſh Water ſweet will be of ſome ſervice; which tho' no new Diſcovery, yet has hitherto, as far as I can learn, been but little put in practice by the *Engliſh*, from a fear they have had of hurting themſelves, by ſuch acid burning Spirits; and this they had great Reaſon to fear, when they knew not in what Proportion ſuch acid Spirits might with ſafety be mixed with Water.

As to the Method propoſed to prevent by the Fumes of burning Brimſtone, Sea-Biſcuit and Corn from being Eaten by Weevels, Meggots, *&c.* I am informed by ſeveral Seafaring Perſons, many of whom I have conſulted during the progreſs of theſe purſuits, that this would be of all others moſt Beneficial and Uſeful if it prove effectual. I hope therefore that thoſe whom it moſt concerns, will, from the Hint I have here given, try various Methods and Degrees of Fumigation, till they have fully effected the thing; which I make no doubt will ſo far ſucceed, as to be of very great Benefit.

As to the Salting of Animals whole, this will doubtleſs be of conſiderable ſervice, to furniſh Ships with well-ſalted Fleſh in hot Climates: 'Tis Experience muſt bring the thing to farther perfection, as to the Degree of Salting in due proportion.

It would be of conſiderable uſe towards our farther improving in the ſeveral ways here propoſed for the Benefit of Seafaring Perſons, if they would communicate from time to time, either what Difficulties they have met with, in the Execution of theſe things on the one hand; or, on the other hand, what Benefit and Advantage they have found thereby, as alſo what farther Improvements they have made; theſe all laid together and communicated to the

Publick, will be a farther Benefit to Mankind: eſpecially to that important and valuable part of Mankind, who *ſee the Wonders of the Lord in the Deep*: And who are, under the guidance of Providence, not only our Chief Defence and Security; but alſo the adventurous and induſtrious Inſtruments, by which the ſeveral and moſt diſtant Nations of the Earth carry on an extenſive Commerce and Intercourſe with each other; which tends not only to the greatly inriching, but alſo to inlarging the Minds of Mankind, and to the Civilizing and Improving of them, by the Communication of mutual Benefits.

I have here alſo added an Account of ſome Experiments on Steel-Waters, which tho' it may not, in the main Deſign of it, be thought ſo proper to join to a Treatiſe, which is chiefly intended for the uſe of Seafaring Perſons, yet neither will it be wholly uſeleſs to them; ſince they may hereby be informed, how to preſerve for their uſe in a Voyage, the Virtue of Steel-Waters, which they ſhall any where meet with: And ſuch Waters will doubtleſs, in many Caſes, be as uſeful to them, as they are to many of thoſe at Land.

As to the Propoſal at the end of this Book, to cleanſe ſome Rivers and Harbours of Mud; it firſt occurred to me many Years ſince, on ſeeing the ſlow and expenſive Method, of cleanſing the *Yarmouth* River near *Yarmouth*, by means of a large Wheel fix'd to a Barge, and turned by Horſes. The Wheel in turning round, takes up Mud in large Buckets, which are fixed to it, and diſcharge it into another Barge. A Method which they are under a neceſſity of uſing in *Holland*, where the Waters move with a very ſlow progreſſive motion: But in Waters which have a greater velocity, I am perſuaded that it would be a much more effectual, and expeditious, and conſequently a cheaper and better way, to cleanſe away Mud, by much ſtirring of it thus with Horſe-Rakes.

I ſhall be very glad if what I have here offered, ſhall prove of any ſervice to the Publick, and be conſequently acceptable to Your Lordſhips,

Being with all due Reſpect,

MY LORDS,

Your Lordſhips

Obedient humble Servant,

STEPHEN HALES.

THE PREFACE

I *Did not intend any other Preface to this Treatiſe, than what is contained in the foregoing Dedicatory Epiſtle: But being furniſhed, while the firſt part of this Book was printing, by the Favor of Sir* Hans Sloane, *Bart. out of his Valuable Library, with ſeveral Treatiſes on the Subject; I ſhall from them give an Account of what has been formerly attempted for making Sea-Water drinkable, eſpecially what was done by Mr.* Walcot *and Mr.* Fitz-gerald *in King* Charles *the Second's Time.*

St. Baſil, *in his Homilies, ſays that when Men were caſt on an*

Iſland, where there was no freſh Water, they boiled Sea-Water; and catched the Vapour with Sponges, which they ſqueezed into another Boiler; and having paſſed thus, four or five Times from Boilers thro' Sponges, it became drinkable. This tedious way was uſed before the method of Diſtilling was known, which was an Invention of the Arabs.

Johannes a Gadeſden *ſive* Johannes Anglicus, Anno 1516, *ſays that Sea-Water may be ſweetened four ways,* viz. *by filtrating thro' Sand: By clean Linnen laid over a Boiler, and ſqueeſingthe Moiſture out, as from the Sponges: By Diſtillation: As alſo by thin Bowls made of white Virgin Wax, which 'tis ſaid will free the Water from its Saltneſs, and from ſome part of its nauſeous Bitter. But this is only a matter of curioſity, be-*

cauſe but a very ſmall Quantity can be thus prepared; and in order to make thoſe waxen Bowls fit for farther Filtration, they muſt be cleanſed from the Salt, by being waſhed in freſh Water.

About the Year 1675, William Walcot, *Brother to Sir* Thomas Walcot, *obtained a Patent for making Sea-Water freſh: And the King, before the Grant of this Patent, had the curioſity to go and ſee Mr.* Walcot *do it, which was by diſtilling it in a very large Still; into the Still he put ſome Ingredient, which was to cure the diſtilled Water of any noxious Quality: But what it was, he kept a great ſecret. I ſuſpect that the principal thing was only Diſtillation, becauſe in all his printed Accounts of it, he purpoſely avoids the calling it a Still, but calls it a Machine or Engine,*

gine, and Diſtilling he calls the working of the Machine, not Diſtilling.

The Reverend Dr. Colbatch, *Caſuiſtical Profeſſor at* Cambridge, *who ſome Years ſince deſired me to attempt, to make Sea-Water wholeſome, informs me that he had good Reaſon to believe that the Ingredient which Mr.* Walcot *put into Sea-Water, in order to make it wholeſome, was ſome Preparation of Antimony by Fire.*

In the Year 1683 *Mr.* Fitz-gerald, *Son of the Earl of* Kildare, *and a near Relation of the Famous* Robert Boyle *Eſq*; *having upon Mr.* Boyle*'s encouragement made a Diſcovery of a new eaſy and practicable way of making ſalt Water freſh, obtained of the King the Grant of a Patent to himſelf*, Theophilus Oglethorpe, William Bridgman, Thomas Maule, *and* Patrick Trant *Eſq*; *Lord* Faulkland *being*

being afterwards brought in a Partner.

In the Year 1684 *Mr.* Walcot *had Letters Patent granted him by the* States General, *to make Sea-Water freſh, and putride Water wholeſome: Which Mr.* Fitz-gerald *endeavoured to obtain there alſo.*

After ſeveral Tryals at Law between the Patentees Mr. Walcot's *Patent was ſuperſeded and laid aſide; againſt which Mr.* Walcot *brought a Bill in* Parliament *in the Year* 1694, *which paſſed the* Commons, *but not the* Houſe *of* Lords.

Mr. Walcot *aſſerted before the* Houſe *of* Commons, *that Mr.* Fitz-gerald's *Water was rough, harſh, fiery, corroding and tormenting the Body when conſtantly drank of. This I ſuſpect was the true Reaſon why both their Methods of preparing freſh Sea-*

Water were diſuſed, viz. *becauſe when they had been uſed for a conſiderable time, they were found to diſagree with thoſe who drank them.*

Mr. Walcot *ſays of his Water, that it was ſmooth, ſoft, cooling, and would not decay or putrify in many Years, no not in ſeven Years, when kept at* Conſtantinople. *But by its continuing ſo long in an unputrified State, I ſuſpect there was Spirit of Salt in it, that came over in Diſtillation: For tho' diſtilled common Water is known to keep longer without putrifying, than undiſtilled Water by reaſon of its greater purity; yet I found ſome of the good diſtilled Sea-Water to putrify in ſome time after Diſtillation, but that which had in it Spirit of Salt never putrified. A Gudgeon died the fifth Day after it was put into a Pint of good diſtilled Sea-Water, which*

which after ſtanding five Months in a Glaſs Veſſel, was again become ſo putrid as to be diſagreeable to the Taſte; whereas another Gudgeon put into a like quantity of good diſtilled Sea-Water, lived many Days longer, the Water being very freſh and ſweet, it having been diſtilled but three Days before. I find that a ſmall Degree of Putrefaction in Water, kills Fiſh; but if, in order to prevent that Putrefaction, a few Drops of Spirit or Oil of Vitriol be dropped into the Water, then the Fiſh will live many Days in that Water.

The Patentees depoſited the Receipts of the Cements, and other metalline Compoſitions which they uſed, ſealed up in a ſilver Box, in the Lord Mayor of London*'s hands.*

Mr. Boyle *certified that the few Ingredients made uſe of by Mr.* Fitz-gerald, *are fixed in the Fire, and give no noxious Quality to the Water.*

Sir Hans Sloane, *who ſaw the Cement which was uſed in* Mr. Fitzgerald's *Method, tells me that it looked like common Brick Clay. But whatever it was, there was ſo ſmall a quantity of it uſed; that what was ſufficient for producing Sixty Tuns of good Water, might be contained in two Buſhels.*

But ſince, as is ſhown in the following Treatiſe on Sea-Water, two Ounces of Sal Tartar, *when diſtilled with only a Pint of Sea-Water, were not ſufficient to detain the noxious parts of that Water from riſing, therefore* 4320 *Pounds weight of it, would not be enough to procure Sixty Tuns of good diſtilled Sea-Water: And ſince Salt of Tartar is the ſtrongeſt Imbiber of ſulphureous Subſtances, and the*

the moſt effectual Preventer of the ill Effects of Spirit of Salt that is hitherto known; it ſeems therefore very improbable, that ſo ſmall a Portion of a clayey Subſtance ſhould be more effectual for that purpoſe: which makes me very much ſuſpect, that theſe Cements, as they were called, were only made uſe of as a Pretext.

Were I to aim at a Patent for making diſtilled Sea-Water wholſome, and in order to it would conceal the real eaſy Method of doing it, viz. *by firſt cauſing it to putrify and then grow ſweet again; I might here have a fair opportunity of doing it, by putting in any Compound Mixture, which in order to have its good Effect it might be pretended, that it muſt be throughly digeſted in the Sea-Water; whereby a ſufficient time might* *be plauſibly gained for its Putrefaction*, &c.

Mr. Fitz-gerald's *Method met with ſuch great applauſe, that a Poem was publiſhed to celebrate his Praiſe, and ſilver Medals were made, repreſenting and illuſtrating the Art of this new Inventor.*

One Jacob Kuffler *aſſiſted him; who, the King ſaid, had not the Art.*

A Still *of his was ſet up at* Hull *and* Sheerneſs*: and by Order of the Council in the Year* 1692, *two of them were to be ſet up in the Iſlands of* Jerſey *and* Guernſey*; but with no good Effect: The diſtilled Water was fiery, harſh and corroding.*

And in a little Time the Perſons concerned with Mr. Fitz-gerald, *finding themſelves extreamly diſappointed in their expectation, withdrew from any Partnerſhip with him: Inſomuch*

much that his Inſtruments, which were dear enough before their Effect was known, were ſoon after ſold for old Goods, for want of a vent for them at Sea.

Upon the whole, it ſeems probable to me, that theſe Patentees might ſometimes have wholſome diſtilled Sea-Water, viz. *when they either kept the firſt part of any Diſtillation of Sea-Water for a conſiderable Time after; or if they Diſtilled ſome Sea-Water which had putrified: and this they might probably do, ſince 'tis likely that they were provided with good ſtore of Sea-Water for their Experiments. Now I have ſhown in the following Treatiſe, that in both theſe Caſes, good Water may be obtained from Sea-Water taken up near the* Nore.

And 'tis probable that Mr. Boyle *might happen to try, with a Solution of Silver, ſome ſuch good Water of Mr.* Fitz-gerald'*s preparing, who might likely bring him the beſt Water he had. For it is not to be ſuſpected that ſo worthy and good a Man as Mr.* Boyle *was, would impoſe a Falſhood on the World, for the ſake of any one whatſoever.*

The Solution of Silver in Aquafortis *was at that time kept a great Secret, as to its Property of diſcovering the leaſt quantity of Salt or Spirit of Salt in Water. Had either Mr.* Walcot *or Mr.* Fitz-gerald *had the free uſe of it, and known how to have uſed it, they might then probably have made a greater progreſs in what they were in purſuit of; but for want of it, they could not well diſtinguiſh, when the Diſtilled Water was free*

from

from Spirit of Salt, and when not, and therefore, failed in their Attempt.

It was from the uſe of this Solution of Silver; and the happy Incident of being furniſhed with a quantity of Mediterranean *Water, by* Thomas Tower *Eſq; Member of Parliament for* Wallingford *in* Berkſhire, *that I got the inſight into this Matter; which I have given an Account of in the Treatiſe on Sea-Water.*

The great and only Difficulty that now remains in this Affair, is to contrive how to diſtil great quantities of Water on ſhip-board; and that with ſafety to the Ship from Fire.

It may therefore be of uſe to give here ſome Account, of what was done on ſhip-board, in purſuance of the then current Opinion that Mr. Walcot, *or Mr.* Fitz-gerald, *or both of 'em had made the happy diſcovery.*

They ſay that they placed the Still in the Forecaſtle before the Maſt, in a very commodious manner, ſo that it took up little Room, and was out of Danger.

And a chief Maſter-Builder of the King's Yard at Deptford *certified the* Lords Commiſſioners *of the* Admiralty, *that Mr.* Walcot *had taken great Pains, and made many Contrivances, and good Proviſion for ſafety, and conveniency of Diſtilling in Ships; having brought the manner of placing his Furnaces to great Perfection; aſſuring their Lordſhips, that he would undertake to ſet them up in the ſame manner in any of his Majeſty's Ships.*

In the Year 1683, *a Maſter of a Ship from* Barbados *certified, that in that Voyage they could diſtil not only in fair Weather, but alſo in foul Weather.*

They ſay that ninety Gallons may be diſtilled in 24 *Hours, from a* Still *that is three Feet in Diameter, with leſs than three Pecks of Coals, and proportionably with any other Fewel. And that the whole Room that will be taken up in the Fewel, and in the few Casks to be employed in the preparing this Water, will be leſs than the tenth part of Stowage, now employed for Water only. That the Ingredients for* 100 *Gallons of this Water will not amount to above Twelve-Pence: And that the whole,* viz. *Fewel and Ingredients, will come to about a Farthing a Gallon.*

Another makes the following Computation, viz. *In a Voyage to* Suratte, *there is ordinarily allowed a* Butt *or* 126 *Gallons of freſh Water to a Man; ſomething more than a Buſhel of Coals will diſtil this in a*

Day

Day and a half, or 110 *Buſhels for* 100 Butts. *So that if one* Butt *contain fifteen Buſhels,* 105 *Buſhels will lie in the Room of ſeven* Butts; *by which means thirteen in fourteen parts may be ſaved in Stowage, except ſome few Casks for receiving the Diſtilled Water; which will alſo ſave a great Charge of* Butts.

The Prices of the Patentees, were as follows, viz.

The Still *coſt eighteen Pounds, which will diſtil about* 90 *Gallons in twenty four Hours.*

They are to buy as much of the Ingredients, for this Operation, as will keep the Still going ſix Months or more, at the rate of one Shilling value to each 90 *Gallons.*

And ſhall be obliged to uſe the Ingrediants, leſt the Water be prejudicial to the Health of the Sailors, and *conſequently bring a diſrepute on the Invention.*

Three-Pence the Tun to be paid Yearly by ſuch Ships as uſe the Still.

They propoſe hereby to ſave nine Parts in ten of the Stowage for Water.

But theſe ſeveral Eſtimates are ſet too high; they are founded on a ſuppoſal, that all the Water thro' the whole Voyages of Ships, is to be diſtilled; which will hardly ever be.

I find upon inquiry, that it is uſual for the Eaſt-India *Ships, to have Copper* Still-*Heads fitted to their Kitchen-Boilers, with Worm-Tubs proper for Diſtillation. But it ſeems the Ships-Boilers are not tinned within ſide, and yet they find no Inconvenience in conſtantly boiling their Meat in them: whence there is ſome Hopes, that provided they are kept* *clean from the green Ruſt, which is very apt to be cauſed by ſalt Water, they may then alſo be uſed in Diſtillation. But if any Inconvenience ſhall be found to ariſe by Diſtilling in untinned Copper-Boilers, that Inconvenience would be prevented in a great meaſure, by tinning them; this at leaſt while the tinning laſted; which in much uſing will wear off, and muſt then be new tinned.*

Mr. Walcot *finding that Copper Veſſels gave an ill Quality of Vomiting to the Diſtilled Water, made uſe of ſmall Iron Boilers, which if they could be had of a ſize large enough, would be very proper for the Purpoſe.*

But whatever Veſſels are uſed in Diſtillation, great Care muſt be taken that they are made as clean as poſſible; ſince it is fully proved in the following Treatiſe, the more impure *the Water is which is to be diſtilled, the Taſte of the diſtilled Water will be proportionably the more diſagreeable.*

The Common Boilers in Ships, are of Copper, not round, but flat-ſided like a Box; and are called double Kettles, being divided by a Partition into two; the larger of which has a round Mouth, the leſſer an Oval one: To the round one, the Copper Still-Head is fix'd, to the Crown of which is ſoldered a large Pewter-Pipe called the Swan Neck, on account of its crooked Shape, and to this the Worm-Tub is fixed for Diſtillation.

Theſe Boilers are of ſeveral ſizes, containing from 15 *to* 60 *Gallons, in proportion to the different ſmallneſs or largeneſs of the Ships. The largeſt in* East-India *Ships contain about* 80 *Gallons, and in Firſt-Rate*

Men of War they are much more capacious.

Since good and wholſome freſh Water can now be obtained from Sea-Water, it greatly behoves Seafaring Perſons, to contrive and find out the beſt and moſt commodious Methods of Diſtilling it.

To conclude, As the Water which is procured from Sea-Water, in the Method I am going to give an Account of, ſeems to be in every reſpect as good, as that which is diſtilled from common Water, ſo it is reaſonable to conclude that it is as wholſome. And that common diſtilled Water is wholſome, there is good reaſon to think, from the Experience of many. Mr. Boyle *ſays, that the great Duke of* Tuſcany, *who much conſulted his Health, conſtantly drank Diſtilled Water: And they are ſaid* *in* Italy *to drink it as a Delicacy. A Phyſician at* Breſt *drank it conſtantly, and enjoyed fine Health.*

This good Diſtilled Sea-Water will therefore not only be of uſe in the Days of Diſtreſs, but there may be this further Benefit from it, viz. that it being thereby made very pure, it will not be ſo apt to ſtink as other Water; and may therefore be of uſe when the Ship's Store of Water ſtinks and is very diſagreeable; for the longer good Diſtilled Sea-Water is kept, the better taſted it is, it being thereby freed from Empyreum.

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AN ACCOUNT OF Some ATTEMPTS, to make Diſtilled Sea-Water wholſome.

I.

IT is well known that ſeafaring People, eſpecially in long Voyages, frequently ſuffer great inconveniencies, when their Proviſion of freſh Water, either falls ſhort or fails them; either by long Calms, contrary Winds, Storms which diſable the Rigging of their Ships, or other unforeſeen Accidents; which obliges them to come often to a very ſhort Allowance; and ſometimes to loſe the Benefit of their Voyage, by changing their Courſe to get at freſh Water: Or if they happen to be provided with a *Still*, then, by drinking unwholſome Diſtilled Sea-Water, their Healths are greatly indangered, by the moſt obſtinate and incureable Obſtructions, Scirrhous Tumors, Cachexies, *&c.* as

I have been aſſured, by thoſe who have known by experience, the ill effects of it.

There have both in *England*, *Germany*, *France*, and *Holland*, been ſeveral Attempts made, to make Sea-Water more wholſome. I am informed that the *Lapis Mexicanus*, or a ſoft filtrating Stone in the ſhape of a large Mortar or boiling Copper, is very much in uſe among the *Hollanders*; but will not anſwer the end. It clears the Water from Mud, but will not quite clear it from the ſalt and bitter Taſte. And Mr. *Boyle Godfrey the Chymiſt* ſays, in his *Miſcellaneous Experiments and Obſervations*, that Sea-Water being filtrated through Stone Ciſterns, the firſt Pint that runs through will be like pure Water, having no Taſte of the Salt, but the next Pint will be as ſalt as uſual. The *Comte de Marſilli* in his *Hiſtoire Phyſique de la Mere* ſays, he filtrated Sea-Water, through fifteen earthen Pots, placed over each other; which were filled and tried firſt with Garden Earth, and then with Sand; but it had very little effect, tho' the ſum of the Depth of all the Pots was ſixty five Inches; the Sand did beſt. It has alſo been attempted by ſeveral ways of Diſtillation, as alſo by Precipitation, both with and without Diſtillation, which was attempted with Alkaline Powders, as Coral, Crabs-Eyes, *&c.* with Salt and Oil of Tartar; and alſo with acid vegetables and mineral Subſtances; but all hitherto to no purpoſe. Yet this ſhould not diſcourage us from further Attempts, eſpecially in a Caſe of ſo great Concern, to the welfare of ſo numerous, ſo conſiderable and important a part of Mankind as thoſe are *who occupy their Buſineſs in great Waters:* And whoſe numbers as they have within little more than a Century, greatly increaſed, by a more inlarged Commerce through the World; ſo are they like to increaſe more and more in future Generations; and That eſpecially on the vaſt *Atlantick Ocean*, in proportion as the *European* Colonies in *America*, may more and more increaſe in number of Inhabitants.

But notwithſtanding there have been many Inſtances of Peoples preſerving their Lives in times of Diſtreſs, by the uſe of very unwholſome Sea-Water; yet I find the mention of any Endeavour, to make it more wholſome, ſpoke of with Scorn and Contempt by ſome, as a uſeleſs Attempt. Some who belong to large Ships with numerous Crews on board them, are apt to ſay, where can we have or ſtore ſufficient Fewel, to Diſtill, for the ſupport of ſuch Numbers. Yet we find, that in Queen *Elizabeth*'s time, Sir *Richard Hawkins*, who then commanded a Fleet in the *Indies*, did, when Water had failed them, for many Days, even in the Admiral's Ship, procure by Diſtillation a ſufficient quantity of freſh Water to ſuſtain the People. See Dr. *Shaw*'s *Abridgment of* Mr. *Boyle*'s *Works*, *Vol.* III. p. 220.

And a Perſon told me, that on board an *Eaſt-India* Ship, in which he was; for want of freſh Water, the Ship's Crew was ſuſtained fourteen Days, with diſtilled Sea-Water, which they diſtilled off at the rate of ten Gallons in a Day. The Inſtances of being brought to a very ſhort Allowance of Water, are, as I find upon Inquiry, very frequent: I am informed alſo that many periſh at Sea for want of freſh Water to drink.

An experienced Diſtiller informs me, that with a *Still* that holds thirty Gallons, Water will diſtill at the rate of fifteen Gallons in ſeven Hours, which will take up half a Buſhel of *Newcaſtle* Coals; but in a larger *Still* more will be diſtilled in equal times, with leſs Fewel, in proportion to the quantity diſtilled. Therefore thirty-ſix Buſhels or a Chaldron of Coals will diſtill 1080 Gallons, Wine Meaſure, that is, above four Tuns; or near three

Tuns Beer Meaſure. And as a Chaldron of Coals, weighs about a Tun and half, and a Tun of Water, *Wincheſter* Meaſure 2816 Pounds; hence it appears that Coals will diſtill about three times their quantity or weight of Water. And if fifteen Gallons can be diſtilled in ſeven hours, then fifty-one Gallons may be diſtilled in twenty-four hours, a quantity ſufficient for a great number of Men; which might alſo be much increaſed, by beginning the Diſtillation ſome days before freſh Water is wanted.

And as a Scarcity of Water, can in moſt caſes be foreſeen, for ſome time before; ſo the Diſtillation of Sea-Water may be begun ſome time before it is wanted; ſuppoſe but a Week before, then in that time, a great quantity might be provided by Diſtillation. Suppoſe but ten Gallons were diſtilled in a Day and Night, as in the caſe of the *Eaſt-India* Ship above mentioned, that would come to ſeventy Gallons in a Week: And ſuppoſe it be fourteen Days more before there be an opportunity to provide freſh Water at Land; then by keeping the *Still* going there will be two hundred and ten Gallons diſtilled in thoſe three Weeks. A Proviſion of freſh Water, which will be ſufficient to ſupply a conſiderable number of Men, for that Time. And where the Ships are larger, and the Crews more numerous, a proportionably larger Proviſion may be made for a ſufficient quantity of diſtilled Water for their uſe. But as the much greater part of Merchants Ships, have not many Men on board them, ſo it will be the more eaſy to find means to ſupply them with diſtilled Sea-Water, in caſes of Diſtreſs.

I have made theſe Eſtimates, of the quantities of Water that may be diſtilled, only as a Foundation for thoſe concerned in Shipping and long Voyages, to make their Eſtimates from: For as the Circumſtances of the different Sizes of Ships, and number of Men, and different kinds of loading, and different lengths and natures of Voyages, are very various, ſo thoſe concerned can beſt judge, what proviſion of Fewel, and what ſize of *Stills* and Worm-Tubs will be requiſite.

If the Kitchen Boiler, when not uſed for Cookery, can be made uſe of for a *Still*, it would be very commodious, as not requiring a ſeparate Fire-place, and *Still*. This I have ſeen put in practice in private Families: by having a ſeparate Cover which fitted the Boiler well, with a cloſe Joining; In the midſt of which Cover, was a Hole of a due proportion to the ſize of the Boiler; to which Hole the Pewter-head of the *Still* was aptly fitted; and the Joinings cloſed with a ſtiff Paſte made of Bean or Wheat-flower, with Whiting or Chalk wetted with ſalt Water. And theſe Ship Boilers being made narrower above than at their middle, a *Still* Head may the more eaſily be adapted to them. And there being two Boilers in the Kitchens of ſeveral Ships; for greater diſpatch, they might either uſe them both in diſtilling at the ſame time, or might, if need require, provide hot Water in one, while not uſed in Cookery, wherewith to fill the diſtilling Pot when wanted; which would much forward the Work. If there be room but for a ſmall Worm-Tub, the Water in it may be changed the oftner, as it grows warm; it being eaſy to pump it out, and to pour in cold Water. As to Mr. *Hauton*'s contrivance to ſave the having a Worm-Tub, by cauſing the diſtilled Water to paſs by a leaden Pipe through the ſide of the Ship into the Sea, and then being cooled, to return into the Ship; this Method ſeems liable to too many Objections to be put in practice. See *Lowthorp's Abridgment of the Philoſophical Tranſactions, Vol.* II. p. 297.

If a *Still* is purpoſely bough[illegible]is uſe, I believe it would be moſt adviſeable to have the Pot or Boiler of Caſt Iron, but eſpecially the Head of Pewter: becauſe I ſuſpect that when Salt-Water is boiling in a Copper Veſſel, the heat may make the Salt more corroſive, and thereby more apt to produce, and bring off *Verdigreece* from the Copper; which would make the diſtilled Water apt to cauſe nauſeating of Food, and ſometimes Vomiting; which as I have been informed, has happened to the Inhabitants of *Antegoa*; where being in great diſtreſs for freſh Water, of which they have none but Rain-Water, they had drank for ſome time diſtilled Sea-Water; which obliged them to diſuſe their *Stills*. I hope the following Method of preparing diſtilled Sea-Water, will be of uſe to them in long Droughts, when Rain-Water fails them.

For the ſame Reaſon alſo it is adviſeable to have the *Still* Head of Pewter, and not of Copper, which may probably contract a green Ruſt, in laying long by, in the ſalt Air at Sea. This is what a Perſon told me, had happened to him at Sea; the Water which was boiled in his Tea-Kettle, cauſing him and ſeveral others who drank of it to vomit; which was occaſioned by a green Ruſt in the Neck of the Kettle: And I have heard of ſeveral other the like Inſtances. In anſwer to this, it may be ſaid, that Salt Meat is frequently boiled in Copper Veſſels, without any ſuch ill effects. But then, the Salt is ſomewhat ſheathed in the unctuous Fat of the Meat, whereby its corroſive Acrimony is much rebated. I mention the providing Iron and Pewter *Stills*, rather than thoſe made of Copper, only by way of precaution, being not certain whether thoſe of Copper will have any ill effect, provided they are made very clean. For it is found by Experience, that if Sea-Water ſtand any time in a Copper Veſſel, it will much ſooner cauſe a greater Ruſt than Rain-Water will.

I am informed, that Wood Fewel is chiefly uſed in Ships, which in many Ports abroad, coſts nothing but the labour of cutting and fetching. A greater bulk of this will be wanting to diſtill any quantity of Water, than there will of Coal to diſtill the like quantity. Coals might well be laid in Ballaſt, in a little compaſs, but when Ships are full freighted they have little or no Ballaſt, which is then not to be come at.

But might it not be adviſeable in ſome kinds of Voyages, by way of precaution, to have a Tun, or other quantity of Coals, in ſome proper place, when it would take up but little uſeful Room, eſpecially ſince ſo many Tuns of Water may be diſtilled with one Tun of Coals.

I found by filling a Caſk with Coals ſtrike Meaſure, which held twenty-ſeven *Winchester* Gallons of Water, that though the Coals are about one fourth part ſpecifically heavier than Water, yet the Water weighed one eleventh part heavier than the Coals.

I have been told, that where there has been occaſion to keep a Fire for many Days and Nights continuance, on ſhipboard, for diſtilling of Water, they have by way of precaution from danger of Fire, laid a quantity of Salt on the Planks about the Fire-place.

Here will be no danger of firing the Ship, if the *Still* Head ſhould fly off, becauſe Water will not flame, as diſtilled Spirits will do.

II.

THE particular occaſion of my ingaging in this Attempt to make diſtilled Sea-Water wholſome, was from a Converſation I had with ſome ſeafaring Perſons, who were giving an account of the very bad ſtinking Water, they were obliged often to make uſe of at Sea, and of the great hardſhips they ſometimes underwent for want of enough of that bad Water. Whence it occurred to me, that probably diſtilled Sea-Water might be made more wholſome by *Clarification*, concluding that it abounded with a nauſeous bitter *Bitumen*, as I remembred ſome Authors had ſaid it did: And being fully poſſeſſed with an opinion that it was ſo, I reſolved to make the trial, being provided with a Hogſhead of Sea-Water, which was taken up near the *Buoy* at the *Nore*, at the mouth of the *Thames*, by the favour and procurement of the *Right Hon. the Lord Vere Beauclerc*, one of the *Lords of the Admiralty*.

I diſtilled ſeveral Gallons of it in large Glaſs *Retorts*, pouring what came over into the Receiver, from time to time, into ſeparate Glaſs Veſſels; beginning the firſt pouring off, when it firſt began to boil, that I might the better know, whether it grew worſe and worſe, the farther the Diſtillation was carried on, which was ſometimes done till the Salt in the Water became dry.

I found, the little which was diſtilled off with a more gentle heat, *viz.* till it began to boil, was pretty well taſted; but the ſeven next ſeparate Portions of diſtilled Water, had a flat, unſalt, nauſeous, dry, aduſt Taſte; and the laſt and ninth Portion, was more harſh and diſagreeable, it taſting more of a kind of

Spirit of Salt; for what came over till all was diſtilled to a dry Salt, was in this ninth Portion: But did not find any Taſte like Bitterneſs or Bitumen. And *Comte Marſilli* obſerved the ſame, *viz.* that the bitter bituminous Taſte of diſtilled Mediterranean Sea-Water, was ſcarcely diſcernible, when taken up from the Sea, within four or five Inches of its Surface; but if taken up at greater Depths, for the deeper the more bituminous; then he ſays, there is a bitter Taſte, which it is difficult to free it from: For after moſt exact and repeated Diſtillations, the Water, tho' freed from its Salt, yet retained a kind of viſcous glewy Matter; which is to be perceived ſticking to the ſides of the Bottles, when the Water is ſhaken, and which ſlowly precipitates to the bottom, when the Water is not ſhaken, which is not found in diſtilled Fountain Water. But tho' I could not perceive any thing bituminous in this diſtilled *Nore* Water, yet however, I clarified ſeveral Portions of it, with different Degrees of Clarification, both with Whites of Eggs and Iſinglaſs, but all to no purpoſe; it was indeed of a more mild, and leſs nauſeous Taſte: But that, I found, was owing to the ſoft mucilaginous quality of the Subſtances, with which I clarified; which only covered the nauſeous noxious quality of the Water, but did not free the Water from it.

But having once begun, I reſolved to make farther Enquiry, by what probable means I could at firſt think of, or ſhould during the proceſs, get any hint of, from ſuch Experiment as ſhould be made. For it is by making variety of Experiments, and the light which we get, by comparing the Events of them together, that we get hints for farther and farther reſearches: Following thereby as near as we can, the *Clue* by which Nature leads us, into her more ſecret receſſes. And tho' this Treatiſe is principally intended for the uſe of ſeafaring Perſons, yet I hope, thoſe of them, who are not uſed to Philoſophical Reſearches and Reaſonings, will excuſe me, while I firſt give a ſhort account of ſome previous Experiments, which tho' they do not directly deſcribe the beſt Method of preparing good diſtilled Sea-Water; yet may be of ſervice, to explain the nature, and noxious quality of common diſtilled Sea-Water.

Having therefore Reaſon to ſuſpect, from the Taſte of this diſtilled Water; but eſpecially from the laſt Portion of the Diſtillation, that there was a Spirit of Salt raiſed by the heat of the Fire, and mixed with the diſtilled

Water; I diſſolved ſome Silver in double *Aquafortis*, according to Mr. *Boyle's* Direction, *Vol.* I. *p.* 54. of Dr. *Shaw's* *Abridgment*, and dropped ſixty Drops of this Solution into an Ounce of pure diſtilled Spring-Water. Then putting about half a ſpoonful of the ſeveral Portions of the diſtilled Water into different Wine Glaſſes; I dropped into each of the Glaſſes two Drops of the Solution of Silver, diluted in diſtilled Spring Water; which immediately cauſed white Clouds in the clear diſtilled Sea-Water; which were leaſt in the firſt Portion, and nearly the ſame in all the other Glaſſes, except the laſt, which had much whiter and thicker Clouds. Whence it was evident, that there was ſome Spirit of Salt in all the diſtilled Water. For as Mr. *Boyle* obſerves, if there be any common Salt, or its Spirit, in the Water into which the Solution of Silver is dropped; that Salt or Spirit immediately ſeizing on the *Aquafortis*, it lets go the Silver which it had diſſolved, which is thereby precipitated to the bottom, in the form of a white *Calx*; whereby the leaſt quantity of Salt, or of its Spirit, is diſcovered in any Water; but it will not diſcover Nitre, Alum, or Borax.

And that there is ſome Spirit of Salt in this diſtilled Sea-Water, is further probable from the following Obſervations, *viz.* That this diſtilled Water does not putrifie and ſtink, as common Water does; and even Sea-Water, which will putrifie and ſtink much tho' it has Salt in it. Now I have found by often repeated Experiments, that three Drops of Oil of Sulphur, which is an acid Spirit, will preſerve a Quart of common Water, from putrifying, for many Months: And doubtleſs Spirit of Salt, which is an acid Spirit too, has the ſame effect. *Fioravanti*, l. 1. *Phyſices*, c. 95. mentions as a great Secret, that a little diſtilled Sea-Water, mixed with common Water, will preſerve it long from Putrefaction. *Du Hamel Regiæ Scientiarum Academiæ Hiſtoria.* And it is probable this, or Oil of Sulphur, or Spirit of Vitriol, was the Mixture with freſh Water, to preſerve it from Putrefaction, which the *French* were ſaid, not long ſince in the News-Papers, to ſend to Sea.

The following Experiment, is a further Confirmation, that there is Spirit of Salt in diſtilled Sea-Water, *viz.* I put into two Ounces of the laſt Portion, of the Diſtillation to Dryneſs, of Sea-water; a ſmall piece of freſh Beef: And put Beef alſo into the like quantities of well-cured, diſtilled Sea-Water, and alſo of

Rain-Water. In ſeven days, the two laſt were become very fœtid and putrid, and the Waters thick and cloudy; whereas the Beef in the very bad diſtilled Sea-Water, did not putrifie, nor was the Water turbid, but clear as at firſt, though kept ſeven or eight Weeks with the Fleſh in it: And it was obſervable, that the reſtringent Quality of the bad diſtilled Sea-water, was ſo great, that it contracted the Fibres and Blood-Veſſels of the Beef, ſo that no Blood could iſſue out of it; as it did from the firſt day, from the Beef in the other Glaſſes, which had good wholſome diſtilled Sea-Water, or Rain-Water in them.

Now it is not likely, that an oily bituminous Subſtance ſhould have this effect in hardening and preſerving Fleſh; the Effect of ſuch Subſtances is rather to ſoften and promote Putrefaction. In order therefore to make ſome Eſtimate of the Quantity of Spirit of Salt that was requiſite to have this Effect on Fleſh; I put ſome Pieces of freſh Beef into ſeveral Portions of common Water, with different Quantities of Spirit of Salt, and found that the Proportion of three Drops to an Ounce of Water, would preſerve Fleſh from ſtinking for a conſiderable time.

The Action of Fire gives thoſe diſtill'd Salts, what is called a *Polarity*, ſuch as the Filings of Iron have; for when attracted by a Loadſtone, they ſtand an end, and thereby form rough ſharp Points, like little Briſtles: And 'tis in ſome ſuch like manner, that the Particles of Spirit of Salt are to be formed; whereby they acquire a great degree of Acidity, and a reſtringent auſtere Roughneſs.

From this Experiment, we may plainly ſee, how common diſtilled Sea-water works its moſt pernicious Effects, on thoſe who drink it, *viz.* By contracting and purſing up the fine Veſſels and Fibres of the Body: whereby it brings on thoſe inveterate and moſt incurable Obſtructions and ſcirrhous Tumours, which are obſerved to be the Effect of drinking thoſe unwholſome Waters.

And it is almoſt in the ſame manner, tho' by ſlower Degrees, that *Brandy*, *Rum*, *Arrack*, and other diſtilled ſpirituous Liquors, do ſo effectually deſtroy multitudes of thoſe, who indulge themſelves in drinking them. For I have found, by putting raw Fleſh, into the ſeveral ſorts of them, that they all in like manner harden Fleſh, by their pernicious burning, cauſtick Salts, which are more hurtful, tho' of another kind, than thoſe of Spirit of Salt.

And hence it is that *Brandy*, *Rum*, *&c.* deſtroy ſuch Multitudes, eſpecially *in hot Climates*, by adding *Oil* and *Fewel* to the Fire. The Phyſicians of the ſick and wounded Sailors, have aſſured me, that the Effects of theſe Liquors on human Bodies, are ſo pernicious, that their Medicines, have little or no Effect in curing thoſe who have indulged much in *Brandy* or *Rum*.

Thus the *Still*, which makes good Drink, out of unwholſome Sea-Water, procures alſo from wholſome Wine or Malt-drink, a moſt pernicious Liquor, which yearly deſtroys, all over the World, innumerably more, than the three great Plagues of *War*, *Peſtilence*, or *Famine* ever did. It would therefore be ſomething worſe than ſtraining at a *Gnat*, and ſwallowing a *Camel*, for me to be labouring to cure the ill Effects of common diſtill'd Sea-Water; which may be of ſervice to ſome few, in caſes of Diſtreſs; few indeed in compariſon of the vaſt numbers that are deſtroy'd by diſtilled ſpirituous Liquors; and yet at the ſame time not to caution againſt the uſe of thoſe peſtilent Liquors, which may truly be called the *Bane of Mankind:* And which every one, who has any Bowels of Pity for his Fellow-Creatures, ſhould do his beſt to deter them from.

But notwithſtanding it ſhortens the Lives of, and deſtroys vaſtly more, than *Storms*, *Shipwrecks* and other Accidents, to which Navigators are ſubject; yet how fond are they of this inchanting *Syren*, which bewitches and infatuates the Nations of the Earth with its Sorceries? Inſomuch, that were it put to their choice, whether they would chuſe to carry to Sea with them, a *Still* that would draw wholſome Water from the Sea, or one that could extract *Rum* and *Brandy* from Sea-Water; one needs not the Skill of an *Oedipus*, to know which they would prefer.

They pretend that it comforts, warms and defends them, from the ſevere Colds, to which they are ſometimes expoſed, without which, they ſay, they ſhould periſh with Cold: which is probably in a great meaſure true, of thoſe who are much habituated to drink it, the Blood of ſuch, being thereby ſo much impoveriſhed, that it is well known, that many of the habitual Drinkers of *Brandy*, &c. are cold and lifeleſs, even in the midſt of Summer, without frequent freſh Draughts of it. But on the other hand, how much better able, to endure the Cold and Hardſhips at Sea, are the ſober ſeafaring Perſons, who are generally of a more fine, hail, robuſt Conſtitution, than moſt other Men. Their vital Heat, not being extinguiſhed with Intemperance, does by its kindly genial Warmth, more effectually ſecure them from the Inclemency of the Weather, than the falſe momentary Fluſh of Heat which a Dram gives. Beſides, it is well known, that Sailors did not periſh with cold, in former Ages, for want of Drams, when they were not to be had.

Dr. Short, *in his Rational Diſcourſe of the inward Uſes of Water*, obſerves, " That
" it is no rarity, to find among the *High-*
" *landers* of *Scotland*, People of *eighty*,
" *ninety*, yea a *hundred* years old, as
" healthy, as ſtrong and nimble, as Drinkers
" of ſtrong Liquors are at thirty-ſix, or forty
" years of Age." And this Diſparity is doubtleſs much greater, when apply'd to the Drinkers of enervating Drams.

It may not be improper here, to inſert a Panegyrick on Temperance from *Dr*. Short's *Hiſtory of Mineral Waters*, p. 9. A Panegyrick worthy to be recorded in every one's memory. " O! Temperance! thou
" Support, and Attendant of other Virtues!
" thou

" Thou Preſerver and Reſtorer of Health,
" and Protractor of Life! Thou Maintainer
" of the Dignity and Liberty of rational
" Beings from the wretched inhuman Slavery
" of *Senſuality*, *Taſte*, *Cuſtom* and *Example!*
" Thou Brightner of the Underſtanding and
" Memory! Thou Sweetner of Life and all
" its Comforts! Thou Companion of Reaſon,
" and Guard of the Paſſions! Thou bountiful
" Rewarder of thy Admirers and Followers!
" how do thine Excellencies extort
" the unwilling Commendations of thine Enemies!
" and with what rapturous Pleaſures
" can thy Friends raiſe up a Panegyrick
" in thy Praiſe!"

The Doctor farther obſerves in his *Rational Diſcourſe of the inward Uſes of Water*, " What great Succeſs, Victories, and valiant " Atchievements, a pitiful and deſpicable " People, have attained over other Nations, " while they were Temperate: but when " they have taken themſelves to ſwill " down ſtrong Liquors, how have they ſuddenly " become the Prey, and Contempt " of ſuch as they formerly had trodden down. " —— They conquered People and over-ran " Nations, till their Armies began to drink " Strong Liquors, and then they neither could

" conquer nor defend, what they had brought
" under their Yoke."

I hope this ſhort Digreſſion will be excuſed, and taken in good part, by thoſe for whoſe ſervice and welfare it was really intended, by him, who has been labouring to do them the beſt Service he can, and who has ever had a great value and eſteem for *Seafaring* Perſons, on account of that *open*, *brave*, *generous* and *manly Spirit*, which is obſervable in them; and which 'tis a great Pity to have debaſed and broken down, by ſuch pernicious falſe Spirits.

How praiſe-worthy and glorious an Action would it be, for the Legiſlators and Governors of the Nations of the Earth; to uſe their beſt endeavours, to deliver their Subjects from ſo deſtructive a Peſt, and from that worſt of Slaveries, *which it is not in their Subjects power to deliver themſelves from.* This would be a ſurer means to increaſe the real Strength and Riches of a Nation; and a more glorious Atchievement to gain true ſolid Honour and Applauſe, than to inlarge their Dominions by Conqueſt. On the other hand, how inhuman, how diſhonourable, and how groſs a breach of Truſt committed to them by Providence, is it, ſupinely to ſuffer ſo deſtructive a Peſt, to rage amongſt thoſe committed to their charge; a Peſt that ſo greatly debaſes human Nature. It is the peculiar happineſs of this Nation, that the Legiſlature have taken Cognizance of it, ſo as to lay Reſtraints on, and will doubtleſs proceed, to provide an effectual Remedy for ſo great an Evil.

But to return to the Subject of this *Spirit of Salt*; it does not probably riſe from the Perfect Salt which is in the Sea-Water, but ſeems rather to be the Spirit of a more imperfect Salt, which abounds in Sea-Water, and is called *Bittern*. Now the Spirit of this Salt, may probably be raiſed with a much leſs degree of Fire, than the Spirit of common Salt: Becauſe, as the Chymiſts obſerve, it wants a central Earth, which makes true perfect Salt of ſo fixt a nature, that its Spirit cannot be raiſed, without being mixed with powdered Bole or Brick-duſt, and diſtilled in a Retort with a ſtrong melting Fire; whereas the Spirit of imperfect *Bittern* Salt, is more eaſily raiſed with a much leſs degree of Heat, *viz.* that of boiling Water.

Finding therefore ſo great Reaſon to conclude, that it was *a Spirit of Salt*, which, principally made diſtilled Sea-Water ſo unwholſome; and it being a known thing, in the Books of Chymiſts, that Oil of *Tartar*, being mixed with Spirit of Salt, will make true common Salt, as well as ſtrongly imbibe the rancid Sulphur of any Liquor it is put into; I dropped ſixty Drops of ſtrong Oil of *Tartar* into an Ounce of diſtilled Sea-Water, and diſtilled it a ſecond time; it was well taſted, and gave no white Clouds with Solution of Silver. A probable Argument, that the Oil of *Tartar* had ſeized on and fixed the Spirit of Salt, as perhaps alſo ſome of the nauſeous Bituminous Sulphur, and thereby hindred them from diſtilling over into the Receiver. It was alſo the ſame, when I diſtilled half a Pint of diſtilled Sea-Water, with a quarter of an Ounce of *Tartar*, or with *Sal Tartar*. And with Pot-aſh it gave no white Clouds with the Solution of Silver, but it had a very nauſeous ſoapy Taſte; which continued long after.

But two Ounces of *Sal Tartar*, had no ſenſibly good effect, when diſtilled with a Pint of Sea-Water; and it was the ſame when either Sea-Water, or diſtilled Sea-Water, were diſtilled with *decrepitated* Salt, that is Salt burnt in a Pot till it has done ſnapping.

Half a Pint of diſtilled Sea-Water, diſtilled again with half an Ounce of *Calx* of Bones burnt to a white Powder, was well taſted, and gave no white Clouds with Solution of Silver. But if it be not thus diſtill'd a ſecond time, the *Calx* of Bones by ſtanding ſome Days in the diſtilled Water, takes off much of its aduſt Taſte, but does not prevent its giving white Clouds with the Solution of Silver; and whereas, had it been diſtilled a ſecond time, there would have been no ſuch Clouds,' this ſhews that the *Calx* of Bones ſeizes on the Spirit of Salt and prevents its riſing: it was very good three Months after.

Diſtilling a ſecond time with calcined Oyſter Shells, has the ſame good effect, but taſtes ſomewhat more Aduſt, but after long ſtanding is good.

Diſtilling a ſecond time with Chalk, prevents the white Clouds, with Solution of Silver; as alſo with Brick-duſt, which gives a very nauſeous Taſte.

With Burnt Alum, there are very ſmall whitiſh Clouds, and it has a ſmart dryiſh Taſte, but is otherwiſe well taſted; and continues ſo long.

Theſe Diſtillations were made with great eaſe, in ſmall Pint and Half-Pint Retorts;

which were placed in common Pipkins filled with Sand; and then placed on a *Trivet* over the Kitchen Fire, for half an Hour, to be gently warmed; and then, the *Trivet* being taken away, the Pipkin was ſet on a hot place on the Fire. It was eaſy to fit Receivers of any Sizes to theſe ſmall Retorts, by means of Corks which filled the Mouths of the Receivers, and had a ſmall Hole in them, fit for the Neck of the Retort to enter.

Thus we ſee that *Oil* and *Salt of Tartar*, *Calx* of Bones, *Oyſter-Shells*, *Chalk* and *Brick-duſt*, have a good effect in curing the noxious quality of diſtilled Sea-Water: But this, not without a ſecond Diſtillation, which ſo greatly increaſes the difficulty of coming at good Water; that nothing but the moſt urgent neceſſity, could have prevailed with any to make uſe of either of theſe means.

III.

THERE was another Method, which I had thought on, to try as ſoon as opportunity offered: and that was to ſee what could be done by Putrefaction. But this, I had as yet no opportunity of trying, becauſe my Hogſhead

head of Sea-Water, having hitherto had its Bung-hole open, did not ſtink. But I was happily ſupplied by a Friend with twenty-two Flaſks of *Mediterranean* Sea-Water taken up nineteen Months before, thirty Leagues North of the Iſle of *Malta*. The greateſt part of this Sea-Water was ſweet, and in Taſte I found no difference between that, and the *Nore* Water.

I cut off the Necks of two *Florence* Flaſks to a wide mouth, and then, having weighed them both, I put into one of them, half a Pound *Avoirdupoiſe* of *Mediterranean* Water; and into the other, the like quantity of *Nore* Water: And then evaporated them both to dryneſs. I found by weighing them again, that there were two Drams or 120 Grains of Salt in the *Nore* Water, *viz.* $\frac{1}{29.2}$ part of the Sea-Water: And in the *Mediterranean* Water 128 Grains of Salt, *viz.* $\frac{1}{27.3}$ part of the Sea-Water, it having one fifteenth part, more of Salt in it.

I diſtilled in a large Glaſs Retort, fifteen Flaſks of the *Mediterranean* Water, which did not ſtink: And I obſerved that during the Diſtillation, its ſmell was not ſo Aduſt and diſagreeable, as that of diſtilling *Nore* Water: The ſmell of this diſtilling *Mediterra-*

nean Water, being mild and ſomewhat urinous. Hence it ſeems probable that by Putrefaction, its *Bittern* Aduſt Salts, are changed in ſome Degree into a kind of *Sal Ammoniack*. For doubtleſs, this Sea-Water had putrified in nineteen Months keeping in Flaſks.

I carried this Diſtillation on, till the Salt was dry at the bottom of the Retort; and pouring it off from time to time as it was diſtilled, into ſeparate Veſſels; I, to my great Satisfaction found, that the firſt four Parts in five of this diſtilled Water, gave no white Clouds with Solution of Silver; had very little more of the Aduſt Taſte, than my Pump-Water, Rain-Water, or the very pure *Combe* Spring-Water, with with *Hampton-Court* is ſerved; all which acquired an Aduſt Taſte by Diſtillation; and the more impure the Water, the more diſagreeable was the Aduſt Taſte, even after it had putrified and was grown ſweet, which was the Caſe of my Pump-Water, which is hard, and has five Grains of Sediment in a Pound of it, evaporated to dryneſs, whereas *Hampton-Court* and Rain-Water have but one Grain and a half. But if theſe diſtilled freſh Waters, or Sea-Water, ſtand for ſome time, either expoſed to the Air, in open Veſſels, or in Bottles, this Aduſt Taſte is much abated; and at length goes quite off.

It is obſervable, that though diſtilled Rain-Water, Spring or Well-Water, have an Aduſt diſagreeable Taſte, yet the Waters which remain in the Retorts, have only the Taſte of common boiled Water: which ſhows that the Aduſt *Empireumatick* Taſte, is owing to the Action of Fire on the aſcending diſtilled Vapours. The Sun indeed can raiſe Vapours from Water, with a very gentle Warmth, and thereby give no ill Taſte to thoſe Vapours, but this cannot be done by diſtilling.

And as a farther Proof of the goodneſs of this diſtilled *Mediterranean* Water; I find it putrifies and ſtinks by ſtanding ſome Days, in a Glaſs Veſſel covered only with Paper, not tied down. And when expoſed to the free open Air, ſoon came ſweet again: whereas none of the *Nore* Water has ſtunk, which was diſtilled before it had putrified, and gave white Clouds with a Solution of Silver; notwithſtanding it has ſtood ſeveral Months in Glaſs Veſſels covered with Paper. And raw Beef, as I obſerved before, putrifies and ſtinks in this diſtilled Water, as ſoon as in Rain Water; whereas the like Beef put into the latter part of this Diſtillation, with which a

Spirit of Salt was raiſed, continued hard and did not putrify in ſtanding ſeveral Months.

IV.

IN order, further to examine into the goodneſs of this diſtilled *Mediterranean* Water; I boiled for two hours, ſome common yellow boiling Peaſe, in ſome of it; alſo in diſtilled *Nore* Water, in *Rain Water*, and in undiſtilled *Nore* Water. The Peaſe which were boiled in the undiſtilled Sea-Water, were duſky coloured and very hard; and ſuch are found indigeſtible, by thoſe who have been obliged to eat them for want of other Food. Thoſe which were boiled in the diſtilled *Mediterranean* Water, were very ſoft and mellow to a Maſh; thoſe which were boiled in the diſtilled *Nore* Water, were ſoft, but not to the ſame degree as the other. Thoſe boiled in Rain Water were ſoft too, but in a leſs degree than the two diſtilled Waters; which ſhows that Diſtillation has more effect in preparing Water to ſoften Peaſe boiled in it, than the ſmall quantity of Spirit of Salt, in the diſtilled *Nore* Water had, to diſqualify it for that purpoſe: But I found that Peaſe boiled in the laſt part of a Diſtillation of Sea-Water to dryneſs, in which there is much Spirit of Salt, were far from being ſo mellow and ſoft.

I obſerved, that when the good diſtilled *Mediterranean* Water had ſtood ſome Weeks, if two or three Drops of *Solution of Silver* were dropped into a ſpoonfull of it; tho' it did not cauſe White Clouds, yet in ſtanding ſome Hours, the Water turned browniſh, with ſome ſediment; and I found it the ſame with my diſtilled Pump-Water: alſo in Rain-Water when tending towards Putrefaction. So that we cannot hence infer any bad quality in the diſtilled Sea-Water. I found it the ſame alſo in the beſt of the ſweet diſtilled *Nore* Water, but not in that which was the latter part of the Diſtillation to dryneſs, which abounded more with Spirit of Salt.

I obſerve further on this Diſtillation, that when about two thirds of the Sea-Water was diſtilled off, there appeared, about an Inch above the Surface of the diſtilling Water, a Circle of whitiſh Salt, ſticking to the ſides of the Retort, which increaſed more and more, as the Water decreaſed by Diſtillation, yet no Spirit aroſe from this Salt, till about four Parts in five was diſtilled off. Hence we may obſerve, that this Spirit of Salt, is not ſo apt to riſe in Diſtillation, from the incruſted Salt, whoſe Water had putrified and grown ſweet, as from the incruſted Salt of Sea-Water that was never putrid.

The way to know, when enough Water is drawn off any one Diſtillation, is, from time to time, to try a little of it in a Glaſs, by dropping two or three Drops of Solution of Silver, as above mentioned.

I purpoſely choſe to make uſe of Glaſs Veſſels, rather than Metalline ones, both that I might the better obſerve what occurred in the Diſtillations, and alſo that I might be ſecure that no ill Taſte was given to the diſtilled Liquors by the Veſſels. In the ſtrongeſt boilings the Ebullition riſes three or four Inches above the Surface of the Water, ſo that care muſt be taken, not to fill the *Stills* ſo full, as to endanger the Water's boiling over into the Neck of the *Still*: And that eſpecially on Ship-board, where there is more danger of the Water's riſing too high, by the heeling to and fro of the Ship; to prevent which, the upper part of the Ship-Boilers are made narrower than the middle parts. I never obſerved any Scum on the Surface of the boiling Sea-Water.

Some of the Flaſks of this *Mediterranean* Water, being very putrid and ſtinking much, I put the Water of none of them into the great Retort, with the fifteen Flaſks of Water. But diſtilled half the Water of one of the moſt putrid of them in a leſſer Retort: The diſtilled Water of this, ſtank intolerably; hence the putrid Particles the moſt volatile, in Diſtillation: But what remained in the Retort, was the next Day ſweet and clear, and had depoſited a dirty Sediment. And putrid Sea-Water does the ſame, as it grows ſweet and clear. And common Salt alſo, as it melts in a moiſt Air, is obſerved to depoſite much Earth, with an unctuous, ſharp, auſtere Liquor.

The diſtilled Water gave browniſh Clouds with a Solution of Silver while putrid; and when grown ſweet again, gave white Clouds, and did not ſtink again in long keeping, an argument that there was ſome Spirit of Salt in it. Whence we ſee how requiſite it is to let Sea-Water not only ſtink, but alſo become ſweet again, in order to procure by Diſtillation, wholſome Water from it.

Sea-Salt is obſerved by Chymiſts, to be made up of an Acid of a peculiar kind, and of a mineral Alkali, the Acid Portion being ſo far intangled, and involved in the other, as hardly to be able to exert its proper Virtues, in a concrete Form: But Putrefaction, that moſt ſubtile of all Diſſolvents, effectually disjoins and ſeparates all the component Parts of putrifying Bodies, except common Salt, which is of ſo fixt a Nature, as not to yield to Putrefaction: which is the Reaſon that it is ſo effectual a preſerver of other Bodies, where there is a ſufficient quantity of it uſed. But there being in Sea-Water not only perfect Sea-Salt, but alſo a more imperfect *Bittern* Salt and Sulphureous *Bittern*, which laſt Principles promote Putrefaction, and are thereby disjoined; and after the Putrefaction ceaſes, are formed into new Combinations: The groſſer of which precipitate to the Bottom; whereby it falls out, that the Spirit of the *Bittern* Salt, requiring now more heat to raiſe it, than before Putrefaction; a conſiderable quantity of the Sea-Water is diſtilled over, before this Spirit of Salt begins to riſe. But when the Diſtillation is made during the putrid State of the Water, its putrifying Particles being then diſunited, the Spirit of Salt more eaſily riſes in Diſtillation.

I think it therefore a happy event, that ſome of this *Mediterranean* Water, had putrified and was ſweet again; and that ſome of it ſtank; otherwiſe if it had all ſtank, and by diſtilling it in that putrid State, I had found it no better than *Nore* unputrid Water, I might probably have been thereby ſo diſcouraged from any further purſuits, as not to think of diſtilling ſome of it, after it was grown ſweet again. By ſuch unforeſeen Incidents is Providence ſometimes pleaſed, to give Succeſs to our Reſearches; and ſo little Reaſon have we *to ſacrifice to our own Net*; as if the diſcovery were owing to our great Sagacity and Penetration.

If we will confeſs the Truth, we muſt needs acknowledge our ſhort-ſightedneſs; *that we ſee but as through a Glaſs darkly. And hardly do we gueſs aright, at things that are upon Earth, and with labour do we find the things that are before us. Wiſdom* ix. 16. Yet how common is it to ſee Men led into the prophane abſurdities of *Deiſm*, from a conceited Opinion of their great Skill, in their ſeveral Crafts and Profeſſions? Thus have I known low Artizans, look upon themſelves, as compleatly qualified for *Deiſts*, from a high conceit they had of their Skill in their

Crafts. And the caſe is but too often the ſame in other Profeſſions, where, in reality, the very much they are ignorant of, ſhould rather make them humble, than the little they know, exalt them.

It is to be feared, that the Spirit of *Deiſm*, which is but too prevailing in our unhappy Days, owes its Riſe, in a great meaſure, among other cauſes, to an over-weaning conceited Opinion Men have, of the great Strength of their Reaſon and Underſtanding; whereby they are led to make themſelves, ſo far the Standard of Infallibility, as even to reject the Counſel of the Alwiſe and Almighty Being, in the Conduct and Government of his own Creation. For by the Divine *Counſel*, as the Wiſe-man obſerves, *The ways of them which lived on Earth were reformed, and Men were taught the things that are pleaſing unto thee, and were ſaved through Wiſdom. Wiſdom of Solomon* ix. 17, 18. Had they therefore but Humility enough to make a juſt Eſtimate of human Abilities, for Humility is a Virtue full of good Senſe, that would neither have us under, nor over-value ourſelves; they would then perceive, how great Reaſon they had to be thankful, for whatever further Aſſiſtance, beyond natural

Abilities, God would vouchſafe to give us, in order the better to conduct ourſelves.

It is obſervable that the Deiſtical Spirit is plainly ſeen in many of them, under the Air of great Self-ſufficiency; as if they, by the dint of their ſuperior Underſtanding, had diſcovered the Cheat, which held Mankind under the Reſtraint and Bondage of Revelation. Yet theſe profeſſed Enemies to Faith, muſt needs own, if they will but obſerve it, that in almoſt every other part of Life, in which our Underſtandings are employed, we find inceſſant Occaſion, to act on the fidelity and report of others; for no one Man can himſelf try all things. If therefore they would give things Spiritual, but an equal treatment, with the common Occurrences of Life, they might then bid fair for a full Enjoyment of the gracious Promiſes of the Goſpel, which they now moſt ſenſeleſſly reject with ſcorn. *Thus profeſſing themſelves Wiſe, they become Fools. Rom.* i. 22.

But to return to the Subject of this diſtilled *Mediterranean* Water: I found that the fifth Part of it, which was diſtilled to dryneſs, turned Syrup of Violets Red; which Spirit of Salt alſo does: An Argument, that there is

Spirit of Salt, in this laſt diſtilled Sea-Water; the Acidity of which is alſo very manifeſt to the Taſte.

But good diſtilled *Mediterranean* Water does not change the colour of Syrup of Violets; whence there does not appear to be any prevailing Acid in it.

But neither did the laſt part but one of the Diſtillation of this *Mediterranean* Water change the colour of the Syrup of Violets, notwithſtanding it gives White Clouds, with Solution of Silver; which therefore diſcovers to us ſmaller degrees of Spirit of Salt, than Syrup of Violets will do. Hence we have a hint to be careful not to diſtill off any quantity of Sea-Water, too near to the bottom, becauſe it will thereby, the more abound with Spirit of Salt, and be conſequently ſo much the more unwholſome.

And that the quantity of this Spirit of Salt increaſes more and more, in proportion as the Diſtillation is carried on farther and farther, I was convinced by the following Obſervation, *viz. Jan.* 29th I examined a large Diſtillation of *Nore* Water which had not putrified, which was kept in eight ſeparate Flaſks according to the order of its being diſtilled off, which was done the preceding *October* 13th.

It had all loſt its adust Empyrume: And about one third of it gave no white Clouds with Solution of Silver, but the other latter parts of this Diſtillation, gave very manifeſt Clouds, and taſted ſomewhat more tart and rough than the other: Now this whole Diſtillation from firſt to laſt, gave white Clouds at firſt, and for ſome Weeks after; when I firſt perceived that the quality of giving White Clouds ſenſibly abated. This ſhows, that there is not much Spirit of Salt raiſed in the firſt third Part of a Diſtillation of unputrified Sea-Water; and that the little of it there is, is ſo incorporated in the Water by long ſtanding, that the Solution of Silver has no effect upon it. In like manner as I have frequently found that a ſmall quantity of Oil of Sulphur, or Spirit of Vitriol, would on long ſtanding be incorporated into Chalybeate Waters.

Hence we ſee that there is much Spirit of Salt in the latter part of this Diſtillation.

Hence alſo we may draw this uſeful Inference, that in caſes of diſtreſs, if there ſhould be no Water in the Ship that has ſtank and become ſweet again; we may with ſafety make uſe of diſtilled Sea-Water that is juſt taken out of the Sea; provided only ly one third Part of it be diſtilled off; for 'tis probable that the ill effects of diſtilled Sea-Water have principally ariſen, from Men's not being enough aware of the ill Conſequences, of carrying the Diſtillation on too far.

V.

Jan. 29th, I diſtilled 22 Cubick Inches of the *Nore* Water out of the Hogſhead, which was well cloſed up *December* the ſecond, in order to cauſe it to putrify. Some time after, the Water in the Hogſhead had a diſagreeable Smell, and then grew ſweet, and continued ſo to this Day. It is remarkable that with ſo ſmall a degree of Putrefaction, the Water which was diſtilled over was good, till the Salt which adhered to the Retort had appeared for ſome time, whence its Spirit aroſe as uſual. There were ſixteen Cubick Inches diſtilled over, which were good, which is full three fourths of the whole.

Both the ſmell of this during the Diſtillation, and alſo its taſte were much better than that of unputrified Sea-Water.

December the ſecond I put ſome *Nore* Water into a Kilderkin and bunged it up cloſe, where after ſome time, it contracted a putrid Smell, and Taſte, and then became ſweet again. Some of it being diſtilled *Jan.* 29th, it gave no White Clouds with Solution of Silver, though above two thirds were diſtilled off: Hence again we ſee that this ſmall degree of Putrefaction will ſuffice, for the producing of good diſtilled Sea-Water.

But this diſtilled Sea-Water, was much more nauſeous, than that out of the Hogſhead, ſo that ſome of the impurity came over in diſtilling, which the Water had contracted from the Kilderkin; which had for many Years paſt had Beer in it; yet it was waſh'd with hot Water. Thus I have conſtantly found diſtilled Water the more nauſeous, in proportion to the foulneſs of the Water it was diſtilled from.

Hence the Empyreumatick taſte, does not ſeem to depend on Fire Particles inherent in the Water, but rather from a new diſagreeable Combination of the more impure parts of the Water; whereas were it owing to Fire Particles, that aduſt Taſte ſhould be more nearly the ſame, whether the Water were pure or impure.

Nov. 28th, I put ſome Iſinglaſs into ſome ſweet *Nore* Water, in order to make it putrify, which it ſoon did in ſome degree, and continued to do ſo more and more till *Jan.* 29th, when I diſtilled ſome of it in that ſtinking State. It, to my ſurprize, gave no Clouds with a Solution of Silver; and when ſweet, which it ſoon became, it taſted as well as the good diſtilled *Mediterranean* Water. Hence we ſee that, notwithſtanding the *Mediterranean* Water which ſtank when diſtilled, gave white Clouds, and continued to do ſo for ſeveral Months after it was diſtilled; yet that this *Nore* Water tho' diſtilled in a putrid State proves very good; as it does alſo, when diſtilled after it is grown ſweet again. I cannot gueſs at any other Reaſon for the different event of theſe two putrid Waters, unleſs it be that the *Mediterranean* Water was in a more highly putrid State, ſo as to be turbid, whereas the *Nore* Water ſeemed to be putrid in a leſs degree, and was pretty clear.

It ſeems probable, that it will be more requiſite, to have Sea-Water putrify and grow ſweet again in the warmer Climates, and where it abounds moſt with Bitumen; becauſe thereby the Bitumen will be rendered leſs volatile, and be in a great meaſure precipitated to the Bottom of the Caſks, before it be put into the Still, whereby what is diſtilled will be the purer.

VI.

Comte Marſilli ſays, this Bitumen is in ſuch plenty in the *Mediterranean* Sea-Water, particularly on the *Thracian* Sea, when calm; and in ſuch abundance on the *Eaſt-Indian* Sea, that it is ſometimes ſeen ſwimming on the Surface of the Water, which he believes to come in a good meaſure from Coal Mines; ſome of it may alſo come from *Petroleum* which is in many Parts of the Earth. He diſtilled ſome Mineral Coals, and found that forty Grains of the oily volatile Spirit of Coals, put into a Quart of freſh Water, which was made as ſalt as Sea-Water, made it as bitter as the ſurface Sea-Water: and that fifty Grains of that Spirit, put into a quantity of Artificial Salt-Water, made it as bitter as the deep Sea-Water.

He ſays alſo, that the Sea-Salt which is made at *Peſcais* near the Mouth of the River *Rhone*, is ſo bitter and diſagreeable, that it can't be uſed the firſt Year, and ſcarcely the ſecond; that it is tolerable the third; and the fourth Year its Bitter is ſcarce to be taſted; and this, whether the Salt be made by Art or the Sun.

That the Taſte of the Salt made by the Diſtillation of the ſurface Water, is of a biting Saltneſs, with an almoſt intenſe bitterneſs: But that the Taſte of the Salt of diſtilled deep Water is of a greater degree of Saltneſs, and a more diſagreeable Bitter.

He ſays that diſtilled Sea-Water is ſo diſagreeable, that it is impoſſible to drink it, *viz.* on account of the great quantity of its *Bitumen*, which is more diſagreeable than the ſaline Part. But this is happily cured by Putrefaction.

If Bread is made with Sea-Water, he ſays it gives a good Colour, and makes it light; but that the *Bitter* which is taſted the next day, makes it intolerable. And that *Mutton* boiled in *Sea-Water*, is more Salt and Bitter than in *freſh Water*.

He obſerves, that there is ſomething loſt in Diſtillation; for though the Salt thereby taken out, be reſtored to the Water, yet there wants an addition of more Salt, to bring it to its former Specifick Gravity, *viz.* forty Grains in two Pounds.

That there are in two Pounds of Sea-Water, eight Drams and ſix Grains of Salt;

and in an hundred Pounds, 402 Drams thirty Grains, yet in the Diſtillation there were found in two Pounds of Sea-Water, but ſix Drams thirty Grains: And in an hundred Pounds 325 Drams. And it is the ſame, when common Water is made as ſalt as Sea-Water and then diſtilled.

He found alſo, that two Pounds of Fountain Water will diſſolve half a Dram of Salt more than diſtilled Sea-Water, though their Specifick Gravities are the ſame; this he thinks is owing to the *Unctuoſity* of the diſtilled Sea-Water.

He laying the Salt of ſuperficial Sea-Water, taken within ſix Inches of the Surface, and the Salt of deep Sea-Water on blue Paper, the firſt Salt turned the Paper Red as Nitre will do, but the other Salt had no ſuch effect.

I dipped ſome Blue Paper in the melted Brine of the Salt, both of the diſtilled *Mediterranean* and *Nore* Water, and then dryed the Papers, which both gave a reddiſh caſt: But a like Paper dipped in a ſtrong Brine of common Houſhold Salt, had not ſuch a reddiſh Colour, which ſhows that the Bittern Salt of Sea-Water is partly Nitrous. And ſince Chymiſts obſerve that Nitre conſiſts of an *Oily Saline*, and *Volatile* Subſtance, no wonder that Nitrous Salt ſhould be formed in the *Bittern* Salt and *oily Bitumen* of Sea-Water: And it is ſuppoſed to be owing to the great plenty of this Nitrous Salt, that Sea-Water is obſerved to be more unapt to extinguiſh Ships on fire, than freſh Water. It was obſervable that the Papers which were dipped, in the Colliquation of the Reſidue of the Diſtillations, melted again much ſooner, and in a greater Degree, than the Paper dipped in the Brine of common Salt, *viz.* becauſe of the imperfect bittern Salt which was in them.

This *Bittern Salt*, of which there is great ſtore in the Sea, is thought to enter much into the Compoſition of the Nouriſhment of Plants and Animals.

It is from this probably, that that *Univerſal Salt* ariſes, which as it happens to fall on different Earths, concretes, and corrodes them, and thereby produces different kinds of Salts; the more common whereof, and ſuch as are found Natural, are *Vitriol*, *Alum*, *Nitre*, *common Salt* and *Sal Ammoniac*.

And 'tis probable that from the ſulphureous *Bitumen* of the Sea, is raiſed by the warmth of the Sun, that *ſubtile Sulphur*, with which the Air, and its Waters, *viz.* Dew and Rain are impregnated; which makes them ſo kindly and congenial for the Nouriſhment of the Products of the Earth: And when the Air is much impregnated with theſe ſulphureous Vapours; they cauſe violent Ferments with purer Air, whence *the Exploſions of Lightening*; as I have ſhown in my *Analyſis* of the Air.

VII.

I conclude there will be little or no difficulty in being provided with Sea-Water that has putrified and grown ſweet again; ſince as ſoon as any Freſh-Water Caſk is emptied, it may be filled with Sea-Water; which I am told is the conſtant Practice in many Ships, in order to preſerve a due Proportion of Ballaſt, &c. And when the Caſk is cloſe bunged down, this will promote Putrefaction; as will alſo the Filth and Sediment, of what remained of the freſh Water. But the Putrefaction may be haſtened, by throwing in a few Scraps of any animal Subſtance, whether it be of Fiſh or other Animals. This I found, that *Iſinglaſs*, which is a fiſhy Subſtance, ſoon cauſed it to putrify. And in warm Climates where the Sea-Water abounds moſt with *Bitumen*, it will, both on account of the greater quantity of *Bitumen*, as well as of warmth, be the more diſpoſed to putrify.

When the Sea-Water is well putrified, it will be convenient to uſe means to make it grow ſweet again, *viz.* by opening the Bung-Holes, as alſo by throwing in a little clean Sand, which will help to fine down the Water, by precipitating its turbid Filth. But I have not found Sand to haſten the ſweetening of ſtinking Sea-Water that was clear; but when turbid and thick, the Sand will then have a good effect, in carrying all foulneſs down with it; as it is well known to do when mixed with ſlimy Iſinglaſs in fining of Wines.

As new diſtilled Sea-Water, though freed both from Spirit of Salt and Bitumen, has but an indifferent flat aduſt Taſte; this may in ſome degree be helped, by expoſing it as much as the Time will permit, to the Air, and pouring it often to and fro: Mr. *Boyle Godfrey*, in his *Miſcellaneous Experiments and Obſervations*, adviſes the putting in a few Grains of Salt, or a little Sugar, to give it a Taſte. Powder of well-burnt Bones will much take off the aduſt Taſte.

Some are of Opinion that diſtilled Water cannot be wholſome, becauſe they ſuſpect that it is thereby deprived of its nouriſhing Quality. As new diſtilled Water is leſs palatable than the undiſtilled, ſo it may not probably be ſo congenial to our Bodies, on account of that new Texture that is given to ſome of its Parts; to which its diſagreeableneſs ſeems principally to be owing, and not to its being deprived of its nutritive Parts. For when I had ſet by, for a conſiderable Time, ſome good diſtilled *Mediterranean* Water, it became very well taſted, like other common Water, notwithſtanding it was all that Time in a well corked Bottle, ſo that it could not have any freſh *Pabulum* or nouriſhing Quality communicated to it out of the Air; which was excluded by the Cork of the Bottle. And when diſtilled *Nore* Water, which had a diſagreeable Empyreuma, was diſtilled over again with Salt or Oil of Tartar thrown into it, which detained the heterogeneous Parts of the Water from riſing in Diſtillation, the diſtilling Water was then free from Empyreuma, notwithſtanding it had undergone the Action of Fire now, as much as in the firſt Diſtillation. Water is to be looked on chiefly as a Vehicle of Nouriſhment; and if that Vehicle be deprived of its former noxious Qualities by Diſtillation, we may then reaſonably hope, that it may be tolerably good, for conveying Nouriſhment, the being blended with which may alſo much amend it, tho' it be not ſo agreeable to the Taſte, nor altogether ſo congenial to our Bodies as other freſh Water.

VIII.

1ſt. Upon the whole, we may obſerve, as far as appears from theſe Experiments and Obſervations, that the beſt Method to procure wholſome Water from the Sea, is firſt to let it putrify well, and then become ſweet before it be diſtilled, by which means the greateſt proportion of good Water may be procured from any one Diſtillation.

2dly. That as appears by the ſtinking *Nore* Water, a ſmaller degree of Putrefaction, and then turning ſweet, will ſuffice to procure about three fourths of good Water from a Diſtillation, at leaſt in theſe Northern Seas, where there is a leſs quantity of Bitumen: Whether this ſmall degree of Putrefaction, will be ſufficient, in warmer Climates, muſt be left to Experience to determine.

3dly. *Nore* Water diſtilled even in a putrid State, yielded good well taſted Water, as ſoon as it grew ſweet, which it ſoon did after Diſtillation.

4thly. That Water kept in a Beer-Caſk, gives a much more nauſeous Taſte, when diſtilled, than from a Water-Caſk.

5thly. That when on account of a ſudden unforeſeen Exigency and Diſtreſs, there is not time to have Sea-Water ſtink, and grow ſweet again: Then, if only one third of each Still full of Water be diſtilled off, but a ſmall quantity of Spirit of Salt will ariſe: And if they will have the precaution to be provided with two or three Pounds of Salt of Tartar, kept dry in Bottles, a very little of this will change the acid Spirit of Salt in the Water, into a more wholſome neutral Salt: But then there will remain the very nauſeous oily Bitumen; the moſt effectual way to be ſecured againſt which, will be, to be well provided with putrid Water if poſſible.

6thly. It will be requiſite alſo to be provided with a ſmall Vial full of a Solution of Silver in *Aquafortis*. A ſmall Bit of Silver, *viz.* no bigger than a Silver Three-Pence, diſſolved in the quantity of a middling ſpoonfull of *Aquafortis*; and ſixty Drops of this dropped in an Ounce of diſtilled freſh Water, will ſuffice. But the Water muſt be diſtilled, elſe, there being ſome degree of Salt in moſt Waters, the Solution of Silver will cauſe white Clouds in them, which will make them unfit for the Purpoſe. The purer the Silver the better. I diſſolved a Link of a Watch-Chain, which having Copper in it to make it the ſtiffer, the Solution was green; yet when ſixty Drops of this were dropped on an Ounce, or about three ſpoonsfull of diſtilled Spring Water, it was clear, and did very well for my purpoſe. I mention this, to put thoſe, who ſhall have occaſion for it, in an eaſy way of procuring it, when they have not an opportunity, either to get very pure Silver, or to purchaſe the Solution of Chymiſts. Two Drops of this Solution dropped into a Glaſs with half a ſpoonful of the diſtilling Water, will preſently diſcover, by the white Clouds it cauſes, if there be any Spirit of Salt riſen with the Water.

7thly. It will be of uſe alſo to obſerve, when a Diſtillation is over, in what degree of the Diſtillation, the dry Salt begins to incruſt on the ſides of the Still; as alſo how far the Diſtillation may be carried on without danger of raiſing Spirit of Salt, after this dry Salt firſt appears. For the *Mediterranean* Sea-Water came over good, a conſiderable time after the Salt appeared on the ſides of the Retort.

Further Experience and Obſervations from Skilful Perſons may hereafter give more light into this matter, which they will do well to communicate, in order to have them made known, for the publick Benefit; towards the promoting of which, I ſhall be very glad if theſe Endeavours of mine ſhall prove of any ſervice: which would give me ſuch a Satisfaction, as would be an ample Reward, for the Labour and Pains, I have taken herein, even tho' they had been much greater.

SOME

CONSIDERATIONS

ABOUT

Means to preſerve FRESH WATER ſweet.

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AS it is well known by common Experience, that freſh Water, preſerved in Caſks is apt to putrify and ſtink to ſuch a degree, that the Drinkers are obliged to hold their Noſes while they drink it; it may not therefore be improper to add ſome Conſiderations on that Subject.

Water when it ſtands ſtagnant for ſome time, eſpecially in cloſe Veſſels, is apt to form a thin clammy ſlimy Subſtance, to change its Colour, Taſte and Smell, and to become very nauſeous, as it grows more and more putrid. To prevent this Inconvenience as much as poſſible, great care is taken to have the Water Caſks very clean. I am informed that if the Caſks have had Wine, Beer, or Brandy in them, the Water will ſtink ſo, as never to come ſweet again, while in the Caſk.

The *Thames* and ſeveral other Waters will ſtink in ſeven or eight Days, and ſometimes ſooner, eſpecially in unſeaſoned Caſks, and come ſweet again: By opening the Bung-Hole, Waters often become ſweet in twenty four Hours, and ſooner, when much ſhaken, or poured to and fro. The Water would ſtink more, if the Bung-Holes were not left partly open. But putrid Water, tho' nauſeous, is not obſerved to be hurtful to human Bodies.

Dr. Boerhaave in his Chymiſtry, Vol. I. p. 598, ſays that when Rain Water ſtinks, if it be juſt boiled, all the living Creatures in it will be killed; and on ſtanding to ſettle a while, they will ſubſide with other Sediment, to the Bottom: Then being acidulated with ſome pure acid Spirit, the Water is obſerved to become moſt wholſome: And that by the ſame means, *viz.* by adding a little Spirit of Vitriol, Water may be preſerved from putrifying, or breeding Inſects, and yet be withal very healthful: But as he has not mentioned what proportion of this acid Spirit ſhould be put in, and as a ſmall Error in exceſs of the quantity of this very acid Spirit, may render it far from wholſome, even very hurtful and noxious; I will here give an Account of what Experiments and Obſervations, I have made on this Subject, in endeavouring to preſerve the Virtue of Chalybeate Waters.

I have found that three Drops of Oil of Sulphur in a Wine Quart of Water, have preſerved the Water from ſtinking for many Months, and even two Drops to a Quart of very pure Spring Water, which came from a gravelly Hill, which was all Gravel to its Surface, have preſerved it ſweet for more than ſix Months: I have obſerved the Water of ſuch Springs as came from Gravel, to be the pureſt of any Spring Water, it being filtrated through the finer Sand of that Gravel, which conſiſting of innumerable ſmall flinty Stones, give no Tincture to the Water, but purify it as it glides through its fine Meanders. Snow and Hail Waters are the pureſt of any: But Rain Water abounding with Sulphur, eſpecially in hot Weather, is apt to putrify; the purer the Water, ſo much the leſſer quantity of acid Spirit will preſerve it.

I have from my own Experience, and that of others, known Steel Waters drank with three Drops of Oil of Sulphur to a Wine Quart, not only with much ſafety, but with great benefit, when drank only in the quantity of a Quart, or Pint, or Pint and half, in a Morning, for a few Weeks, and for a much longer continuance, in the ſmall quantity of half, or a quarter of a Pint.

But I ſhall not take upon me to recommend the uſe of this Proportion of Oil of Sulphur, or Spirit of Vitriol, in the much larger quantity of Water which is daily drank on Ship-board, leſt while I am endeavouring to do what Service I can to Seafaring Perſons, I ſhould imprudently do them harm. Yet ſince the Trial may be made with ſafety, in the leſſer quantities of Water abovementioned; and ſince it is well known that Phyſicians frequently preſcribe, to the great benefit of their Patients, twenty four Drops of Elixir of Vitriol, to be drank in a Draft of *Spaw* Water, or other Liquor, for ſome Days continuance; in which twenty four Drops there are no leſs than eight Drops of Oil of Vitriol, according to the *London Diſpenſatory*; which ſuppoſing the Draft of *Spaw* Water to be half a Pint, is above ten times more acid Spirit, than theſe three Drops to a Quart: There can therefore be no danger in making the Trial firſt in ſmall quantities of Water; which may from time to time be encreaſed, as from Experience ſhall be judged proper. Neither would I propoſe to have the greateſt part of the Ship's Water-Caſks thus acidulated with Oil of Sulphur or Spirit of Vitriol, but only ſome few of them, to be made uſe of where the Ship's Water is extremely nauſeous, and till ſome of it can be made more drinkable by expoſing it to the Air, &c.

If any one ſhall therefore care to make the Trial, and without Trials, few uſeful Improvements are made; they may take their Eſtimate from hence, without being at the trouble of counting every Drop they put into a large Caſk of Water, *viz.* I found that twenty Drops of Oil of Sulphur, which dropped ſlowly from a Bottle, weighed twelve Grains: Therefore an Ounce *Troy*, or 480 Grains weight of Drops, will be in Number eight hundred: And there being in a Beer Hogſhead ſeventy two Gallons or 288 Quarts, theſe at three Drops to a Quart, will take up 864 Drops, that is one Ounce, and ſixty four Drops, or thirty eight Grains weight.

And as I have, as above-mentioned, found that a Quart of very pure Water was preſerved long ſweet, with only two Drops of Oil of Sulphur, it will be adviſeable to try that leſſer quantity too, which may be uſed with much greater ſafety, if it will be effectual to prevent the ſtinking of the Water, which I believe it will do in purer Waters, in a great meaſure.

I have frequently obſerved, that when three Drops of Oil of Sulphur have continued in a Quart of Water for ſome time, that the little acidity it gives, has gone quite off, ſo as not to be taſted, the acid Spirit being then more intimately incorporated with the Water.

That two or three Drops of true Oil of Sulphur to a Quart, will prevent the breeding of Inſects in Water, is probable from the following Experiments and Obſervations; *viz.* *July* 5th, four Drops of Oil of Sulphur to a *Wincheſter* Quart and half a Pint of Rain Water, killed the little Inſects in it, in twenty-four Hours; a leſs quantity will therefore probably prevent their growth, in their minuteſt Origin, when they are of a much tenderer Conſtitution. But as the Inſects grew ſtronger, *viz.* *Auguſt* 10th, eight Drops of Oil of Sulphur, to a like quantity of Water, did not kill them in three or four Days. But ten Drops killed them in two or three Hours, in the ſame quantity of Water.

I have chiefly mentioned Oil of Sulphur, becauſe it is looked upon, as ſomewhat more kindly to Animal Bodies, than Spirit of Vitriol, tho' the difference between them is but little: But as it is more difficult and coſtly to make Oil of Sulphur by the *Bell*, than to diſtill Spirit or Oil of Vitriol, therefore they are, as I am informed, frequently ſold, the one for the other.

Mr. *Boyle Godfrey* the *Chymiſt*, in his *Miſcellaneous Experiments and Obſervations*, " adviſes the putting in an Ounce of " true Spirit of Vitriol to every forty Gal- " lons of Water, which is at the rate of " three Drops to a Quart; he ſays true Spi- " rit, becauſe the Spirit of Vitriol uſually " to be met with, is only Oil of Vitriol " mixed with Water, which Oil he would " not adviſe to be uſed, becauſe it is a more " metallick Acid than the Spirit, which is the " more Phlegmatick, or lighter Part that " comes up firſt in Diſtillation: If the Oil " is ever uſed, a third part of the Weight " of it does, that is one Ounce of it for three " of Spirit. —— This Spirit or Oil will be " very proper for Seamen in hot Climates,

" by hindering a too great Perſpiration.—
" It is ſuppoſed there are not many conſump-
" tive Men in a Ship, for whom Mine-
" ral or other Acids are not good. Page
" 136, 137.

Agreeably to what Mr. *Godfrey* obſerves of the different Degrees of Strength of Spirit and Oil of Vitriol, I have found that one Drop of true Oil of Vitriol has preſerved a ſmall degree of the tinging Virtue with Galls, of the Steel Water near *Claremont* in *Surrey*; whereas none of the tinging Virtue of that Water was preſerved, with three Drops of true Spirit of Vitriol. I obſerved alſo that the efficacy, and conſequently the acidity of three Drops of true Oil of Sulphur, was nearly equivalent to that of one Drop of Oil of Vitriol, it having almoſt the ſame effect on *Claremont Water*. So that three Drops of this Oil of Sulphur were ſomewhat ſtronger than three Drops of the Spirit of Vitriol. It is therefore very requiſite to obſerve Mr. *Godfrey*'s Rule, *viz.* to put but one third of Oil of Vitriol, ſince it is comparatively ſo much ſtronger. And ſince Oil of Vitriol is uſed in making Elixir of Vitriol, which is frequently preſcribed, with ſafety; we may thence reaſonably infer, that there is little danger in uſing Oil of Vitriol, provided the above mention'd Rule be obſerved.

I am informed, that the *Dutch* in long Voyages, to prevent the Water from ſtinking; always put into it, before they ſet out, a quantity of Spirit of Vitriol.

In the *Hiſtory of the Academy of Sciences, Ann.* 1722, it is ſaid, that freſh Water has been preſerved from putrifying or breeding Inſects for ſix Weeks, by fuming the Caſk with burning Brimſtone, as is frequently done to preſerve Wine and Cyder. And if when a few Gallons of Water are put into the fumed Caſk, the Bung be put in, and it be rolled to and fro; this will make the Fumes more effectually incorporate with the Water; as it does by the ſame means with Wine and Cyder.

DIRECTIONS

To preſerve

Ship-Biſcuit and Corn

From being

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THERE is another great Inconvenience to which Seafaring Perſons are frequently expoſed, by having their Proviſion of Biſcuit and Corn much ſpoiled, by being eaten by Worms, Meggots, or Weevels, eſpecially in long Voyages; which Inconvenience might probably be in a great meaſure prevented by the following Means, *viz.*

It is well known that the Fumes of burning Brimſtone, are moſt deſtructive of animal Life; and will therefore, not only deſtroy living Animals, but will alſo prevent the growth of them in Bread or Corn, which is packed up in cloſe Veſſels, in which the Air is ſtrongly impregnated with theſe Fumes; which it is well known by repeated Experience, have a Power of deſtroying, or reducing to a fixt unaierial State, the more wholeſome vital part of the Air.

Having

Having therefore filled the Caſks with Bread or Corn, or any other vegetable Subſtance which is liable to be worm-eaten; bore ſix or eight Holes in one head of the Caſks, and two Holes in the other Head, more or leſs, as Experience ſhall prove to be beſt; all of them about the ſize of common Quart Corks.

And that the Corn may not drop thro' theſe Holes, nor the Bread ſtop them up; it will be convenient to nail within ſide of each Head of the Caſks, three or four ſticks, about an Inch thick, theſe ſticks having a piece of Hair-cloath, or very coarſe Sack-cloath, laid on them, will prevent the falling thro' of the Corn; and yet give room for the Fumes of the Burning Brimſtone to aſcend: And the ſticks, without a Hair-cloath, will prevent the Biſcuit from immediately covering the Holes.

Having therefore provided a ſufficient quantity of pieces of Tow, or Linnen Rags dipped in melted Brimſtone: If the Caſks are to be fumed on ſhore, then, having dug a Hole in the Ground about a Yard deep, and eighteen Inches wide; throw into the Hole, more or leſs, as Experience ſhall ſhow beſt, about a quarter of a Pound of the Brimſtoned Tow or Rags, ſet on Fire; Immediately placing over the Hole, the Caſk, with that end which hath moſt Holes in it, undermoſt, for the Fumes to aſcend thro' them, into the Caſk; which yet they would not do, if there were not ſome Holes in the upper Head of the Caſk, to give vent for the Air to aſcend thro'.

When you gueſs the Brimſtone is burnt out, and that the Caſk is full of Fumes all over; which it will be, when they have aſcended for ſome time thro' the upper Holes, then drive Corks into the upper Holes, and turning the Caſk ſide-ways on its Bouge, immediately cork up the lower Holes. The tighter the Caſk is, the better and the longer it will keep the Fumes in; and prevent the entrance of freſh Air, which would promote the breeding of Inſects.

But if by reaſon of the too great cloſeneſs of the Hole in the Earth, it ſhall by experience be found, that the great ſmother of the Fume, extinguiſhes the burning Brimſtone; then a leſs deep Hole may be made uſe of, on which a Caſk may be ſet with both its Heads out; the Bread or Corn Caſk being ſet on this, at ſuch a height from the burning Brimſtone, as to prevent the Bread or Corn, being ſcorched by it; for which purpoſe about a Yard will be high enough: If need require, there may be two or three Holes boared in the ſides of the headleſs Under Caſk, or ſome ſpace left at the bottom, in the Earth, to give vent enough to keep the Brimſtone burning.

'Tis probable that by this means, Biſcuit, Corn, &c. may be long preſerved from being worm-eaten. But in caſe it ſhall by experience be found needfull to renew this Fumigation, eſpecially in ſome long Voyages; it may be done with great ſafety on ſhip-board in calm Weather. *viz.* by placing a Caſk on Deck with its upper Head out; in the bottom of which let there be near a Foot depth of Ballaſt, preſſed hard down, with a kind of hollow Baſin in its middle, wherein to lay the burning Brimſtone.

Not only Bread and Corn Caſks may be thus fumed again, if need require: But alſo the Bread in the Bread-Room, if infected with Weevels or Worms, may by being thus fumed in Caſks, have all the Vermin deſtroyed, which will conduce much to the preſerving of the Bread, by leſſening their number, tho' they cannot thus be wholly extirpated: Becauſe the Bread-Room it ſelf cannot well be fumed at Sea, while the Ship is full of People: Tho' it may ſafely be done, when in Harbour; by burning then ſome Brimſtone in it, on a thick Bed of Ballaſt; in a ſhallow open Tub:

which would for a long time preſerve the Room from being infected with this Vermin.

I am told, that it is by ſome ſuch means, that all the Rats in Ships are deſtroyed when in Harbour. But I muſt again, and again, caution againſt uſing any Fumes of burning Brimſtone under Deck, while any Perſons are there; for they will inſtantly be ſuffocated before they are aware of it.

When the Weevels are got into the *Malt* or Corn in a Grainery, they might eaſily be deſtroyed; by putting the Weevelly Corn into Caſks or Cheſts, or large Caſes made of Boards, which being placed over Holes in the Ground, with burning Brimſtone in them, would ſoon deſtroy all living Animals in the Corn, and a great deal of Corn may be thus cured of Weevels, *&c.* in a little time.

The Weevels in a Grainery full of Corn, may alſo be deſtroyed in the following manner, *viz.* Let there be many Holes boared in the Boards of the Grainery of ſuch a ſize, that the Corn cannot fall thro', or elſe let there be in ſeveral parts of the Floor, large Holes cover'd with Laths, on which Hair-cloaths are to be laid, as in Malt-Kilns. And having provided a large quantity of Tow dipped in melted Brimſtone; if the Ground-

Floor of the Grainery be of Earth, lay ſeveral heaps of this brimſtoned Tow, as big as a Man's Head, in the proportion of about four heaps to every twelve Feet ſquare; taking care, not to place them near the Walls. But if the lower Floor be covered with Boards, then lay the parcels of Brimſtone on heaps of Sand or Earth, eight or twelve Inches thick, and laid on Tiles or Bricks, and hard preſt down, to prevent the melted Brimſtone's getting thro' it: And for greater ſecurity, I uſed to put the Earth into common Waſh-Tubs. If the Floor on which the Corn lays, be ſix Feet diſtant above the burning Brimſtone, there will be no danger of its catching Fire: Yet for fear of miſchief, great care muſt be taken. All Doors and Windows muſt be cloſed as much as poſſible. If there are ſeveral Graineries over one another, the Fumes, will paſs thro' all with great velocity and acrimony.

The Fumes of burning Brimſtone placed thus under the Corn, will aſcend through it, with great velocity and acrimony: But if the burning Brimſtone is placed above the Corn, tho' confined in a cloſe Place, the Fumes will not then deſcend into the Corn, as I have found by experience, having put in a Muſlin Rag Ants, at the bottom of ſuch fumed Corn, but they were not killed thereby.

I

I have fumed whole Malt thus very ſtrongly; and then being ground, brewed with it; it gave no Taſte to Beer, that I could perceive. The probable effect of fuming it will be, that it may prevent the Beer's working too faſt: For this is well known to be the effect of ſuch Fumes on Wine and Cyder.

I fumed thus alſo ſome Sea-Biſcuit, Peaſe and Wheat, in a large glaſs Veſſel, which was repeated again after ten Days; yet they had no ill Taſte: And expoſing them for ſome time to the open Air, would probably free them from the very little Taſte it gives. I ſowed the Peaſe, which grew, ſo that the vegetative quality of them was not ſpoiled; but the vegetative quality of the Wheat was thereby wholly deſtroyed, for none of it grew, tho' ſown three ſeveral Times, at ſome Weeks diſtance. It will not therefore be adviſeable to fume Corn thus, which is intended to be ſown. Tho' it will probably prove an effectual means to preſerve Corn that is to be eaten: Which will be of great uſe, eſpecially in hot Climates, where, I am informed, that the Corn is in great quantities ſpoiled by this Vermin.

When the *Weevel*, &c. have got into a Caſk of Bread or Corn, there is no doubt but that thus fuming will deſtroy them: But it is doubtful whether their Eggs will thereby be ſpoiled: If therefore on experience it ſhall be found, that young ones are hatched from thoſe fumed Eggs, in ſome little time; then, if theſe laſt hatched Weevels are deſtroyed by another Fumigation, before they live long enough to lay Eggs; this will be a means to prevent their increaſe for a long Time: But I think it probable, that if the fumed Caſks are ſo cloſe as to admit no freſh Air, that the Eggs will ſcarcely hatch; or if they do, that the very tender young ones, cannot live and thrive, in ſuch an Air.

Since the vegetative Quality of Wheat, is deſtroyed by the Fumes of burning Brimſtone, a Hint may hence be taken, for an improvement in making of Malt, *viz.* By thus deſtroying the vegetative Power of Barley; which may probably be done, by laying it on the Kilns, and burning a good quantity of Brimſtone under it, for half an Hour, or an Hour; the Fumes of which will aſcend thro' it, tho' laid to any degree of thickneſs. And if they ſhall be found to have the ſame effect on Barley as on the Wheat, then the Root of the Barley will not ſhoot; and conſequently ſo much leſs of the Subſtance of the Grain will be exhauſted in Malting, on which account, the Malt will be proportionably better. This may firſt be tryed by fuming only a handfull of Barley well, and then ſeeing if it will grow when ſown in the Earth, or put in Water. Great care muſt be taken, not to come near the upper part of the Kiln while the Brimſtone is burning, leſt they ſhould be inſtantly ſuffocated.

DIREC-

DIRECTIONS
FOR
Salting ANIMALS whole,
IN ORDER
To make the FLESH keep Sweet
in hot CLIMATES.

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AS the Difficulties and Hardſhips which ſea-faring People labour under are many and great; not only on account of their being reduced to the great ſtraits of a very ſhort and ſcanty Allowance, of wholeſome freſh Water; and ſometimes periſhing for want of ſome to drink: So are they alſo oftentimes put to great Difficulties and Hardſhips, for want of wholeſome Proviſions to eat, eſpecially in long Voyages, and in hot Climates, which often occaſions the ſpoiling of their ſalted Fleſh, by the evaporating away of the Pickle, whereby it either becomes putrid and ſtinks, or is exceeding hard and dry, with little or no nouriſhing Virtue in it, cauſing thereby dangerous Scurveys. I hope therefore, the following Directions, for making Fleſh take Salt very well, in the hotteſt Climates, will be of great ſervice, by ſhowing them how to provide themſelves with it there, when they have occaſion, either thro' the badneſs or want of ſuch Proviſion.

I have met with ſeveral who not underſtanding Anatomy, have looked on the Operation, as too difficult to be brought into common uſe: But on the contrary it will be found on Trial, moſt eaſy to do. I have by once ſhowing, directed a common Butcher how to do it; and the Surgeons on Shipboard can ſoon inſtruct any one, how it is to be done. And Neceſſity, which is ſaid to be the Mother of Invention it ſelf, will ſoon, doubtleſs make Men expert, in performing a thing already invented. And I am informed, that it has already been put in practice in a hot Climate with ſucceſs.

A ſufficient quantity of Brine or Pickle muſt be made with common Salt, in the proportion, of two Pounds and a half of Salt, to a Gallon of Water, which when boiled and ſcumm'd, will be nearly in the proportion of three Pounds of Salt to a Gallon of Water; which is the moſt that, that quantity of Water can diſſolve; ſo that if there were more Salt in the Water, there might be danger of its not entering in an undiſſolved ſtate, into the fine Blood-Veſſels.

The quantity of Salt, in half a Pound of *Mediterranean* Sea-Water being 128 Grains, *i. e.* $\frac{1}{27.3}$ of the whole, and a Gallon of Water weighing ten Pounds and three Ounces, there is in a Gallon of Sea-Water, five Ounces, three Drams, and twenty-eight Grains of Salt; which is about the ninth part of the Salt, which a Gallon of Water can diſſolve. Hence we ſee, to how great a degree, a very ſalt piece of Beef, may be freſhened, by being laid to ſoak in Sea-Water.

In order to ſalt an Ox whole, it will be convenient to provide forty or fifty Gallons of Brine or Pickle: For what is not injected into the Arteries, will ſerve to put the pieces of Fleſh in, being firſt made ſtronger than with only three Pounds of Salt to a Gallon, as is done at the *Victualling-Office*.

For a Hog, Sheep, or Deer, provide five or ſix Gallons of Pickle; when you intend to uſe the Pickle, let it be made pretty warm, and have ſome cold by you, to bring it at once to a due Temper, *viz.* ſomething more than blood-warm. If it were cold, by contracting the Blood-Veſſels, it would probably paſs with more difficulty: And for the ſame

Reaſon it is adviſeable to infuſe the Brine as ſoon as the Animal is dead, leſt when cold and ſtiff, it ſhould not be able to penetrate thro' the rigid and contracted Veſſels.

Let the Animal bleed to death by cutting the *Jugular* Veins, whereby more Blood will be evacuated, than in the common way of knocking them on the Head, and then cutting their Throats, and the Fleſh having by this means leſs Blood in it, it will the better keep on being ſalted. If you happen to cut a large Artery, tye it up, by drawing a Packthread round it with a crooked needle, elſe much of the Pickle will be waſted thro' it. If the Creature has done bleeding before it be quite dead, as will ſometimes happen, then haſten its death by a blow on the Head.

Then laying the Animal on its Back, a little inclining to its right ſide, open its Belly, and turning the Caul and Bowels from the left Side; find the great Artery where it lays cloſe to the left Side of the Back-Bone, at the ſmall of the Back, below the Kidneys. And having cleared the Artery of the Fat, and thin looſe Skin that covers it cut it half aſunder a-croſs; and then ſlit it, with a pair of Sciſſors, length-ways, a little more than the length of the ſhort end of the braſs Cock *E. D.* [*Fig.* 1.]; then thruſt into the Artery, towards the Heart, the longeſt end of the Cock *B. E.* ſo far that the ſhorter end *E. D.* may enter the other part of the Artery: Then having with a crooked Needle paſſed pieces of Packthreads under the Artery between *B. E.* and *E. D.* tye the Artery faſt to each end of the Cock *B. D.* If in an Ox the Share-Bone, be opened carefully with a Cleaver, juſt over the Bladder, it will be eaſier to come at the Artery, the Belly being thereby opened the wider.

For an Ox, the Diameter of the Braſs-Pipe *B. D.* may be near half an Inch; and the length of the end *B. E.* four Inches, of *E. D.* two Inches; For if both ends were of an equal length, it would be difficult to faſten each end of the Artery, becauſe the ſlit of the Artery muſt be ſo much the longer to give room for the end *E. D.* to enter it.

For Sheep, Hogs, or Deer, the Diameter of the bore of the Braſs-Pipe *E. D.* may be almoſt two tenths of an Inch; the longeſt end *B. E.* two Inches and a Quarter, and the ſhorteſt end *E. D.* one Inch and half, each end running taper, thereby the better to enter the Arteries; with a ſwelling and nitch at *r. r.* as in the Figure here referred to. Thereby to prevent the tied Arteries from ſlipping off at either end.

Then having a linnen Rag twiſted and tied round the upright end of the Cock *A*, thruſt it faſt into the end of a Spaniſh-Reed or hollow Cane, tying it faſt. The Cane to be eight or ten feet high for an Ox, and five or ſix Feet for a Hog, Sheep or Deer, theſe heights being nearly equal to the height to which the Blood is raiſed in theſe reſpective Animals, by the force of the Heart, as I have ſhown in my *Second Volume of Statical Experiments*: I have therefore choſe herein to imitate Nature, by making uſe of a Force nearly equal to that with which, the Blood is by the Contraction of the Heart, drove thro' all the Blood-Veſſels of the Body; but perhaps a much leſs force may do, which thoſe who have opportunity will do well to try.

When I reflect on the great Number of Experiments of this kind, which I had made ſeveral Years before on Animals, it ſeems very natural thence to have fallen on this Method of ſalting Animals whole; yet I did not think of it, till ſeveral Years after; when upon a ſea-faring Man's telling me, of the very bad ſtinking Fleſh, they were ſometimes obliged to eat at Sea; it preſently occurred to my thoughts, that Fleſh might be made to take Salt in hot Climates, by thus infuſing Salt Pickle through their whole Subſtance.

Care muſt be taken in tying the Cane above, to ſome proper ſupport, that it hang ſo true as not to diſtort the Artery, by too much raiſing or depreſſing either end of the Braſs Cock *B.* or *D.* whereby the ſmall branching Arteries, which go from the great one, to each Rib may be over-ſtrained or broken, which would diſorder the Experiment, and cauſe a great waſte of the Brine thro' the broken Arteries.

The long Reed or Cane being thus fixed to a proper ſupport, with a Tunnel in the top: Firſt ſtopping the Cock, fill the Tunnel and Cane with blood-warm Brine, then open the Cock, and the Brine will flow freely thro' the whole Subſtance of the Animal; the Tunnel muſt be kept conſtantly filled as the Brine ſubſides. And if by any Accident the Tunnel and Cane are empty, then ſtop the Cock again, till they are refilled, otherwiſe Air will be drove into the Arteries with the Brine, which will hinder the entrance of the Brine into the finer Veſſels: by this means you will find the Brine flow and inſinuate itſelf into every part of the Animal's Body in the ſame manner as the Blood does, it being conveyed by the ſame Veſſels; and this you will ſoon be convinced of, by making a ſmall cut, in any of the extremities of the Body, as the Noſe, Tail, Ears, or Feet, at any of which Places the ſalt Brine may be taſted.

I have obſerved that during the Operation, the Brine flows to waſte too freely, thro' the Windpipe, and cut *Jugular Veins* of Sheep, and probably it may be the ſame in Deer, tho' it does not flow there ſo faſt in Oxen or Hogs. But this may be prevented by putting a Cork into the Windpipe, and by tying a Cord hard round the Neck, to ſtop the Veins.

I have let the Brine flow thus, into the Arteries of an Ox for half an hour, and into Hogs and Sheep for a quarter of an Hour; which is doubtleſs a due time, when the Fleſh is intended to be throughly ſalted afterwards with dry Salt, when cut in ſmall pieces, in order to keep it long for Sea-Service; and probably Experience may ſhow, that a much leſs time will ſuffice; for if once the Fleſh be throughly ſoaked with Brine, it will doubtleſs imbibe dry Salt, faſt enough, to preſerve its inmoſt Parts from putrifying, even in the hotteſt Climates: For Fleſh thus prepared, is obſerved, to imbibe Salt, much faſter than other Fleſh.

But I believe, the flowing in of the Brine for a much ſhorter time, may be ſufficient, to make Fleſh keep a few days, for the uſe of a Family at Land, or for a Ship during the firſt part of its Voyage, putting it into a ſtrong Pickle: But if it be to be kept many days, it muſt be rubbed firſt with dry Salt, and layed to drain a few days, as is done at the *Victualling-Office*, where they cure the Fleſh in the following manner, *viz.* they firſt rub it with white Salt only; then put it into Brine for five days to drain the bloody part out, for 'tis the Blood that is moſt apt to putrify: Then they pack it in Caſks, ſtrewing white and *Bay* Salt between each laying; then fill the Caſk up with Pickle made of Water and Salt boiled ſo ſtrong as to bear an Egg: They put three Pounds and half of Salt to a Gallon of Water. The proportion of Salt, Pickle included, is, to an hundred Weight of Fleſh, four Gallons and a half of white, and one and a quarter of *Bay* Salt.

The Pieces thus ſalted with dry Salt, after the infuſion of the Brine or Pickle, muſt be laid to ſoak for ſome time in Water, before they be uſed; elſe they will be apt to be too ſalt: The dry Salt, as before obſerved, ſoaking very faſt, into the thus brined Fleſh; ſo that there is not the leaſt danger, of its not keeping ſweet; there ſeeming rather, to be more danger of its being by this means too ſalt: Which may doubtleſs by further Experience be better regulated and proportioned, to the longer or ſhorter time it is intended to keep it.

I will here give an Account of the event of ſome Trials which I made, having ſalted whole in this manner, four Hogs, three Sheep, and two Oxen.

I find that Fleſh ſalted in this manner requires much boiling, it being very moiſt and full of Gravy, tho' well taſted. It is too ſalt to Broil or Roaſt, with only the infuſion of Brine.

I have found a piece of it, which had only the Brine injected thro' the Arteries, keep ſweet ten Days, tho' hung up in the Chimney-corner, yet ſometimes it would not keep ſweet ſo long. An argument that it may probably be good in hot Climates for a few Days, without the addition of dry Salt, and ſome Days longer with a ſmall ſprinkling of ſome dry Salt, eſpecially if put into ſtrong Brine.

When ſalted well with dry Salt, which the Fleſh imbibes moſt freely, it will keep long, even tho' heated much with hunting, juſt before it is killed: As I found by the Fleſh of a Sheep, which was purpoſely hunted by a muzzel'd Dog for twenty-five Minutes. From whence we may reaſonably conclude, that Fleſh thus ſalted, will take Salt, and be preſerved good, even in the hotteſt Climates.

Beef and Mutton thus ſalted, eat very well, as alſo Pork.

The Ox which was thus ſalted, the 17*th* of *April* 1736, at the *Victualling-Office* on *Tower-Hill*, before ſeveral of the *Lords* of the *Admiralty*, and *Commiſſioners* of the *Victualling-Office*; having its jugular Veins cut aſſunder, there flowed out eighteen Quarts and a Pint of Blood *Winchester* meaſure, in forty-one Minutes, which Blood weighed forty-ſix Pounds and a quarter.

After the Brine had flowed freely for ſome time, with the force of a Column of Brine eleven feet high, ſome of it came frothy thro' the Windpipe, from the Lungs, but what came from the Noſtrils was clear.

The Brine flowing in thus, freely, for about half an Hour, the Body of the Ox was greatly ſwelled all over. There was about forty

Gallons of Brine uſed, much of which was waſted, tho' a great deal of it had ſoaked into the Fleſh and Fat, the quantity of which would have been greatly increas'd, in proportion as the Operation had continued longer. Some of the Brine ouzed into the Stomach and Bowels.

The Ox by eſtimation of experienced Butchers, who are well known to gueſs pretty nearly to the Truth, weighed five hundred and a half. But with the Brine in it, it was found to weigh eight hundred, one quarter and eighteen Pounds: So that it increaſed in weight, on account of the Brine, two hundred, three quarters and eighteen Pounds.

The Carcaſs had not waſted above two Quarts, in hanging whole two Nights: But in cutting into ſmall four-Pounds pieces, it waſted fifty two Pounds more, by draining off of the Brine.

I procured from the Victualling-Office, an Account of the event of this Experiment on the Ox, *viz.* Two Caſks of this Fleſh, which was not ſalted with dry Salt, ſoon ſtank to a very great Degree; as I alſo found in ſeveral Inſtances, that Fleſh thus ſalted with Pickle only, would not keep many Days, without being alſo further ſalted with dry Salt.

The Fleſh of two other Caſks of the ſame Ox, which was ſalted with dry Salt before it was packed in the Caſk, being examined eighteen Months after, and a Piece of it being boiled, it was judged not fit for Men to eat, as its Juices were entirely eat up by the Salt, and it fell in Pieces like rotten Wood.

Whence we ſee that it was over-ſalted: It will therefore require further Experience to adjuſt the Degree of ſalting for the uſe of Ships, in hot Climates. I kept ſome of the Mutton of the Sheep that was hunted, and thus ſalted full ſix Months, which proved good, and was not too ſalt, when layed firſt to freſhen a due time in Water.

It has been ſuſpected, that ſalting the Fleſh thus, while hot, may be ſome diſadvantage to it, as to long keeping. It may therefore be well to try whether Fleſh can be thus ſalted when cold: But 'tis to be feared, that in hot Climates, where only this Method is like to be of uſe, Fleſh will ſtink before it is cold.

If any in hot Climates, ſhall deſire only to ſalt one half of an Animal, it may eaſily be done, by ſtopping one end of the Braſs Cock, and fixing only the other end of it into the Artery; ſo as to have Brine flow only through the Artery, that leads either to the fore or hinder half; by which means, part may be eat freſh, and the ſalted part, the following Days.

If any ſhould deſire to keep a part of hunted Veniſon a few days, or to ſend unhunted Veniſon to a great diſtance in hot Weather, it might probably be done, by only thus injecting into the Arteries a little Brine; which might not diſqualify it for Paſties or Boiling.

I have been told, that in order to preſerve Fleſh, in the hot Parts of *America*, they dip thin Cutlets of it, in Sea-Water, and lay it on Rocks to dry, which makes it look like Glew-Cakes; and is called *Jerked* Fleſh.

AN
ACCOUNT
OF
Some Experiments and Obſervations on CHALYBEATE WATERS.

AS ALSO OF

Some ATTEMPTS to find out Means to
have them *Conveyed* to diſtant Places, with
a greater degree of MINERAL VIRTUE
than has hitherto been done.

He will Bleſs thy Waters. Exod. xxiii. 25.

AN ACCOUNT OF Some Experiments on CHALYBEATE or STEEL-WATERS, &c,

MAnkind are bleſſed with innumerable of theſe genuine ſalutary Cordials of Nature, in almoſt all parts of the World; which have been found ſo very beneficial in many Caſes, for procuring and eſtabliſhing of Health, that much inquiry has been made into the nature of them by Phyſicians, who have from time to time, written many Books on this Subject; and given Directions how, and in what caſes they are to be uſed. I am only acting herein the part of a Naturaliſt; it were preſumption in me, to attempt to invade their Province, for which I am in no degree qualified.

Did I indeed hereby ſeek only popular applauſe, and not the real benefit of Mankind; the more ignorant I was in Phyſick, the better chance I ſhould have, to be much cryed up by the unknowing Many: The Truth of this, we may have had full proof of, of late Years, in the Inſtances of ſeveral moſt ignorant Quacks; who have in their turns had a more general Cry of Applauſe given them, than has come to the ſhare of the moſt eminent and ſkilful Phyſicians, with many of which that Faculty abounds. But the Phyſicians may well be content to take this contempt the more patiently, when they reflect that a petulant fondneſs for Quackery is the epidemical Diſeaſe of this Age; not only in oppoſition to theirs, but alſo to other Profeſſions. Did I therefore thirſt after ſuch kind of popular applauſe; I ſhould have a fair opportunity to obtain it; by crying down, under the Cover of a few new Experiments, the antient Sages and Eſtabliſhers of the Science of Phyſick as Impoſtors, and the modern ones as ignorant Cheats. 'Tis in the like baſe diſingenuous and profane manner, that the daring conceited Denyers of the Lord that bought them, thoſe Quacks in Religion, treat the great and important Truths of it. And thus every Wiſeacre State-Quack takes upon him to cenſure the moſt prudent and unexceptionable Conduct in State-Affairs.

The particular Occaſion of my ingaging in the following Experiments, notwithſtanding I had for ſome Years before purpoſed not to meddle any farther in *Philoſophical Reſearches*, was owing to a dangerous Fit of Sickneſs, about five Years ſince; for the recovery of which, my Phyſician very judiciouſly ſent me, to drink the Chalybeate Waters of *Sunning-Hill* in *Berkſhire*; where I, as well as ſeveral others whom he adviſed to drink thoſe Waters, found great benefit, by recovery from dangerous Diſeaſes. And in order to fill up, and amuſe away a few of the many vacant Hours, which ſuch Places both occaſion and require; I reſolved, by ſuch proper Experiments as ſhould occur to my Thoughts, to try if I could find, the ſubtile ſulphureous Spirit, in which I concluded, as it has been generally thought, that the principal Virtue of Chalybeate Waters reſided.

And in order to it, I filled ſeveral *Florence* Flaſks, which contained about three Pints, with the Steel Water, and inverted their Noſes when full, into earthen Mugs full of the ſame Water; and ſet ſeveral of them in a Boiler full of that Water, in the ſame manner as in Exper. LXVI. vol. 1*ſt*. of my *Statical Eſſays*, I had got the quantity of elaſtick

Matter out of ſeveral Waters. I ſet the Boiller on the Fire, and having given the Water a ſcalding heat; an elaſtick Aerial Air-Bubble was by this means formed in the upper part of the inverted Flaſk, which was nearly equal to $\frac{1}{432}$ part of the bulk of the whole Water, and near double the ſize of an Air-Bubble, which aroſe at the ſame time, from a like quantity of common Water. The yellow Ocry Mineral adhered very faſt to the inſides of the earthen Mugs; as is uſual when Steel-Waters are heated in them.

I poured the Air, or elaſtick Spirit, of one of the abovementioned heated Flaſks, up into an inverted Half-Pint full of common Water which had been boiled, to clear it of its Air; and then ſhook it to and fro' to make the elaſtick Matter incorporate with the Water, to which, yet, it communicated no mineral Virtue, nor would it tinge with Galls. A probable Argument, that there is little or no Virtue, as has been thought, in this ſubtile elaſtick Spirit.

Being deſirous to ſee what quantity of this Elaſtick Aerial Matter would riſe from this Water, without Heat, I filled an inverted Flaſk with it; and let it ſtand thus, nine Days; in which time a few Air-Bubbles aroſe to the upper part as big as half Tares, which were in ſtanding longer, reſorbed again into the Water. I found this Water tinged very well with Galls; nor had it depoſited any Sediment or Flocky Thrumbs, as this, and moſt other Chalybeate Waters are apt to do, in ſtanding one, two, or three Days, in any Veſſel or Bottle corked in the common way.

But if in firſt inverting the Flaſk, an Air-Bubble of about half an Inch Diameter were left in the upper part, then the mineral Water ſoon loſt its Virtue of tinging with Galls; and depoſited a Sediment, which was ſooner or later, according as the Diameter of the Bubble was leſs or greater. And accordingly Dr. *Burton* of *Windſor*, who joined with me, in ſeveral Experiments on *Sunning-Hill* Water, obſerved at the ſame time, that the narrower the neck of the Flaſk was, in which he kept theſe Waters with the neck uppermoſt, they would accordingly retain their mineral Virtue, ſomewhat the longer: I found alſo that the Virtue of many other Chalybeate Waters, might be thus long retained in inverted Flaſks *viz.* Thoſe of *Oakingham* in *Berkſhire*, *Cobham* and *Chobham* in *Surry*, *Midhurſt* in *Suſſex*, *Bramſhot* and *Southampton*, in *Hampſhire*, *Tunbridge* and *Iſlington*. But the

Chalybeate Waters of *Hampſted, Middleſex*, and *Frenſham* in *Surrey*, did not retain their tinging Virtue by this means. Tho' with tubulated Corks, the tinging Virtue of the *Hampſted* Waters was long preſerved at *Hampſted*.

Galls are commonly made uſe of to prove, whether any Waters have, or retain their vitriolick Mineral, becauſe it is a Quality peculiar to vitriolick Salts, thus to tinge with Galls, or other aſtringent vegetable ſubſtances. Not that Chalybeate Waters have any true mature Vitriol in them; for that is formed only, from the metallick Chalybeate Salts, in the open Air; and cannot therefore be generated under Water.

Finding therefore the manifeſt effect, that the contact of the Air, on the ſurface of the mineral Water, had in precipitating the Virtue of the Water, by promoting a putrefactive agitation in the Water; I thought of the following Method to prevent the Air's touching the Water in common Bottles; and yet without any danger of burſting the Bottles, *viz*.

I provided ſeveral glaſs Tubes, about ſeven or eight Inches long, and about one tenth of an Inch Diameter in Bore; I choſe ſome of the beſt and leaſt porous Corks I could get; and having burnt Holes thro' them from end to end, with a round-pointed hot Iron; then with a round File I filed the Holes to ſuch a ſize as fitted each glaſs Tube. Then having provided ſome melted Cement, made of equal quantities of Whiting, Bees-Wax, and white Roſin, which will give no ill Taſte to the Water; the Tube having the Poliſh rubbed off at one end, for an Inch and half, on a wet Brick, that the Cement might ſtick the better; it being firſt warmed, was anointed with Cement, and then immediately thruſt into the Hole in the Cork, ſo as to ſtand out full half an Inch above the Cork at *F*, fig. 2. whereby hold might be taken of it, with a wet piece of Pack-thread, tyed round it, to pull the Cork out of the Bottle, if need required, for it cannot be done with a Bottle-ſcrew.

Then having filled the Bottle brim full at the Spring-Head, and the tubulated Cork being well wetted, and rubbed under Water with the Fingers; to clear it of any ſmall adhering Air-Bubbles, thruſt the Cork into the Bottle; yet ſo that the glaſs Tube may not touch the bottom of the Bottle at *H*, leſt it ſhould thereby be broke, or hinder the entrance of the Cork, to its due degree. And thus all acceſs of Air, to the Water in the

Bottle, is intercepted, except that the Air touches the Water, on its ſmall ſurface in the upper end of the Tube at *i.* And the glaſs Tube being open at both ends, the Water can eaſily riſe and fall in it, in proportion as the Water in the Bottle dilates and contracts, by the different Temperature, as to the warmth or coolneſs of the Air; whereby the danger of burſting the Bottle is prevented, which it would do by the dilatation of the Water, if a common Cork, which immediately touched the Water in the Bottle, were tyed faſt down. But the Diameter of the Inſide of the glaſs Tubes, muſt not be very ſmall and fine; becauſe it could not then contain Water enough, in proportion to the ſum of the Contraction of the Water in the Bottle, and conſequently ſome Air would ruſh in thro' the Tube, and ſpread itſelf between the Water and the Cork.

When the Water in theſe Bottles with tubulated Corks, is to be carried to ſome diſtant Place, the Corks ſhould be tyed down, elſe if they be looſen'd at all, the Air is apt to get in thro' the Tube. And when they are packed up for Carriage, they ought not to be put with their Noſes downwards, but upright, or not above half reclining.

I found that by this means, the mineral Virtue of ſeveral Chalybeate Waters might be preſerved for many Weeks, without its precipitating to the bottom and ſides of the Bottles. But if any Air got between the Cork and the Water, then, that Air by its inceſſant elaſtick Action, promoting ſome degree of agitation or ferment in the Water; cauſing the Mineral Particles thereby to diſintangle themſelves from the Water, and to coaleſce into new Combinations, of ſo much larger ſize, as diſqualifies them to be any longer ſuſpended in the Water; they then precipitating to the bottom and ſides of the Bottles, partly in the form of a yellowiſh Ocre, and partly in cloudy Flocks or Thrumbs; the Water thereby becoming effete and vapid.

But I obſerved in the Inſtances of many Chalybeate Waters, that if after they had thus precipitated their Mineral Virtue, they ſtood till they had putrified throughly, for ſmall degrees of Putrefaction will not do, it muſt be ſo great, as to have attenuated their depoſited ocry Sediment, by that moſt ſubtile diſſolvent Putrefaction, to that degree of fineneſs, as to be fit to be taken up, and be intimately incorporated with the Water; that then the Water gave as good a Tincture with Galls, as when firſt taken from the Spring: And as this was obſervable in many Chalybeate Waters, ſo it is a probable Argument, that the principal Virtue of theſe Waters conſiſts in their Mineral Particles being in a fine attenuated State; and not in a ſubtile volatile Spirit, as has been thought. If there were ſuch a Spirit, it could not fly off from the Water, which was confined in the *Florence* Flaſks turned upſide down, unleſs we can abſurdly ſuppoſe it to penetrate and eſcape thro' the Glaſs. Now a Chalybeate Water loſes its Virtue in an inverted Flaſk, as ſoon as in a common corked Bottle, provided a ſmall Air-Bubble be left in the Flaſk.

The late Dr. *James Keill* of *Northampton* told me, that notwithſtanding he hermetically ſealed up, or melted cloſe up, the Noſe of a *Florence* Flaſk, full of a Chalybeate Water from a Spring near *Northampton*, yet it ſoon depoſited its Sediment, and would not tinge with Galls, *viz.* becauſe there was an Air-Bubble left in the Neck of the Flaſk; for he could not ſeal it up without leaving an Air-Bubble. But if the Virtue of this Water conſiſted in a volatile Spirit, which was apt to fly off; it had in this caſe, no way of eſcaping, but thro' the Subſtance of the Flaſk, which is very unlikely.

To conclude that the principal Virtue of Steel-Waters conſiſts in a volatile Spirit, becauſe they have a Chalybeate Sulphureous Smell, ſeems as unreaſonable, as to conclude that the Virtue of many Medicines conſiſts principally, in their volatile odoriferous Vapour, rather than in their other manifeſt Qualities. It is well known that ſeveral medicinal Preparations of Steel, have nearly a like effect, with that of Chalybeate Waters, on thoſe who uſe them; and yet it is not thought that their efficacy lays in a ſubtile Spirit; but in more manifeſt Qualities.

I will here inſert an Obſervation, *viz.* that the Scales which fly off red-hot hammered Iron, when put into Water, will give no Tincture with Galls to that Water, as Filings of Iron will do. An Argument that the vitriolick Virtue of thoſe Scales is deſtroyed by the groſs Sulphur in the burning Coals, in the ſame manner as common Brimſtone deſtroys or demetallizes Iron, when melted by it in a red-hot ſtate.

The above-mentioned Dr. *Burton* carried ſome Bottles of the *Sunning-Hill* Water with ſuch tubulated Corks to *Windſor*, which is about five Miles diſtance; where they retained their tinging Virtue with Galls for ſeveral Weeks.

And the Rev. *Mr. Archdeacon Bridewake*, ſent by Water at my deſire a Steel Water, in Bottles with tubulated Corks, from a Spring near *Southampton*, to Dr. *Bateman* at *Wincheſter*, which is twelve Miles diſtance, which Water, as the Doctor wrote me word, retained its Virtue of tinging with Galls, and its ferrugineous Smell, for ſeveral Weeks.

Dr. *Langriſh* of *Peterſfield* in *Hampſhire* told me that the Steel-Water at *Coſſe's-Mill* near *Midhurſt* in *Suſſex*, being ſent him thence by his Brother to *Peterſfield*, which is ſeven Miles diſtance; did by means of theſe tubulated Corks, retain its Virtue of tinging with Galls a Year after. But 'tis probable, that this Water in ſo long keeping, had putrified and become ſweet again. When Water begins to putrify, it tinges leſs and leſs with Galls, and at laſt not at all: But when the Putrefaction proceeds to a greater Degree, then the mineral Particles are ſo attenuated, as to be fit to be reſorbed and re-incorporated with the Water, in the ſame manner as when in the Spring, as was before obſerved; and the tubulated Cork contributes to keep it in that ſtate, by excluding the Air.

Dr. *Nesbit* alſo preſerved *Iſlington* Steel-Water clear, and with a tinging Virtue, for ſeveral Weeks, with theſe tubulated Corks, at his Houſe in *Baſinghall-ſtreet*; whereas it is well known, that this Water ſoon turns foul, when carried but a little way from the Spring. He obſerved alſo that a Bottle with Oil on the Water, but without a Cork, tinged well, after ſtanding eleven Days at *Iſlington Wells*.

As to *Bath* Water, one whom I deſired to try how long its tinging Virtue might be preſerved in inverted Flaſks at *Bath*, wrote me word, that after ſtanding thus thirty-eight Days, it gave a purple Tincture with Galls; perhaps it had putrified, which regenerates its tinging Quality; *Bath* Water gave a much ſtronger Tincture when it had been in an inverted Flaſk only three Days. Yet others ſay, they found no ſuch effect on the like Trial.

Dr. *Harrington* found that *Bath* Water, after being preſerved two Months in Bottles with tubulated Corks gave a ſenſible Tincture with Galls. And ſome *Bath* Water, which the Doctor ſent me to *Teddington*, in Bottles with tubulated Corks, with a little Linſeed Oil in the Tubes, to prevent the Air's touching the Water, gave a faint bluſh with Galls, and after fourteen Months keeping, this Water immediately gave a whitiſh Colour; whereas *Bath* Water, tho' after ſome Days it becomes greeniſh with Galls, yet when kept in Bottles corked in the common way, it gives no more Tincture with Galls than common Water: A probable Argument that theſe tubulated Corks are of uſe in preſerving that Water, with at leaſt ſome ſmall Degree of Virtue, more than in the common way.

And it is further obſervable, that when I opened one of theſe tubulated Bottles, the Water would not only give this milky colour with Galls, when firſt opened, but alſo for many Days after, tho' the Bottle wanted of being full. And Dr. *Nesbit* obſerved the ſame of *Iſlington* Water. Hence we have a good Hint to try whether it would not be better, that *Bath* and other Steel-Waters ſhould ſtand in a cool Cellar, in Bottles with tubulated Corks, for ſome Days, before they be convey'd to diſtant Places. For ſince the mineral Principles of *Iſlington* Waters, by thus ſtanding for a conſiderable time, acquire ſo great a Degree of Stability, as not to be precipitated in ſeveral Days, by the Action of the Air on the Surface of the Water, in Bottles which are in part emptied: It ſhould therefore ſeem probable, that they will be leſs apt alſo to be precipitated, by the Agitation of long Carriage, than if carried away immediately after the Water is bottled.

I have had alſo ſeveral other Parcels of Water from *Bath*, with tubulated Corks; the Water of ſome of which, was as good as that ſent me by Dr. *Harrington*, and ſome no better than that which is brought in common corked Bottles, tho' no Air-Bubbles got into the Bottles, which they are but too apt to do in ſo long a Journey. Yet notwithſtanding this uncertainty of Succeſs, it may ſure be worth the while, for ſome curious Perſons, when they ſhall have occaſion for *Bath* Water at diſtant Places, to make uſe of theſe tubulated Corks, which will not much increaſe the Trouble or Expence; and yet may poſſibly be the means of farther improving the Method of conveying Steel-Waters, ſomewhat better conditioned, to diſtant Places. And Linſeed Oil was preferred before Oil of Olives, becauſe it will not harden with cold as the other Oil will; which, by ſtopping thereby the Orifice of the Glaſs Tube, might indanger the burſting of the Bottles. 'Tis probable that theſe tubulated Corks might be of ſome ſervice in carrying

ing *Bath* Water, by water to *Briſtol*; and I intended to have had ſome brought by Sea to *London*. The way to ſucceed in uſeful Improvements, is to perſevere, and not to be diſcouraged at a few diſappointments. But as *Bath* Water when once cold, loſes a principal part of its Efficacy, which cannot be recovered by warming again, ſo it were vain ever to hope, to have it conveyed to diſtant Places, with any degree of that Efficacy thus loſt.

I could not ſucceed in ſeveral Attempts to bring *Sunning-Hill* Water in tubulated Bottles on horſeback to *Teddington*, which is twelve Miles; nor *Midhurſt* Steel-Water to *Farringdon* in *Hampſhire*, which is twelve or fourteen Miles. Nor could I ſucceed in ſeveral Attempts to bring *Tunbridge-Wells* Water good to *London*, by means of tubulated Corks; tho' very carefully ſecured by *John Hooker* Eſq; of *Tunbridge* Town; to whom I am obliged for communicating to me many Experiments and Obſervations which he made on thoſe Waters. But though we could not convey them thus to *London* good conditioned in the Summer part of the Year; yet ſince in the Winter part of the Year, he obſerved theſe Waters to keep pretty good for Months, even in Bottles uncorked, and longer when corked, but not when they were half full: Hence in the Winter part of the Year, we might hope for ſome better Succeſs, in carrying them to diſtant Places with tubulated Corks.

The Steel Water at *Frenſham* near *Farnham* in *Surrey*, which preſently gives a fine Tincture with Galls at the Spring, did not retain its tinging Virtue, with a tubulated Cork, tho' the Bottle was not removed to a diſtant Place, but ſtood in a Houſe near the Spring. As this Water comes out of a very ſoft Sand, ſo I ſuſpect that its great proneneſs to precipitate its Mineral Virtue, is owing to the finer part of this fine duſty Sand, which by its weight precipitates it, in the ſame manner, as it is well known to fine down Wine or Cyder.

The Steel-Water near *Claremont*, in the Pariſh of *Cobham* in *Surrey*, which ſprings out of a pure white Sand, retains its tinging Virtue well for Months in tubulated Bottles, kept in the adjoining Houſe; but it loſes much of its tinging Virtue, and proportionably precipitates its Mineral Sediment, in carrying no farther than to *Hampton-Court* or *Teddington*, which are but four and five Miles diſtant. So that notwithſtanding the Air is intercepted from acting on the Water in the Bottles, by means

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of the tubulated Corks, yet the Agitations in ſo few Miles carriage, gives the Mineral Particles ſo much Motion, as to cauſe them to combine and precipitate; and the warmer the Weather, the more apt they will be to do ſo.

This Spring in *Cobham* Pariſh, is lately opened by *James Fox* Eſq; the Lord of the Manor, and made commodious with ſome Buildings, for the uſe of ſuch as come to drink of its Waters.

Theſe tubulated Corks can be of no ſervice in preſerving the Mineral Virtue of *Pyremont*, *Spa*, or the like Waters, which abound with an elaſtick Aerial Spirit; and which riſing in great quantities from ſuch Waters, will ſoon form an Air Bubble, between the Cork and the Water; which totally defeats the uſe of theſe tubulated Corks.

Thus have I given a ſhort account of what theſe tubulate Corks can, and cannot do; as well in order to explain what Influence the contact of the Air, on the Surface of the Water, has towards promoting the Precipitation of the Mineral Virtue of theſe Waters; as alſo in hopes, that they may in ſome Caſes be of uſe, at leaſt for Perſons who live at ſmall diſtances from ſuch Waters.

For tho' Mineral Waters muſt ever be beſt when drank at the Spring-Head, when their Mineral Particles are in the moſt ſubtile and attenuated ſtate; and conſequently fitteſt to enter the capillary Veſſels of the Body; yet when in caſes of Sickneſs, bad Weather, or other Incidents, a Perſon cannot go to the Spring, it may at leaſt be of ſome advantage, towards preſerving ſome farther degree of Virtue than can be done without ſuch means: For it is a common Obſervation, that *Bath* and *Tunbridge* Waters ſenſibly abate ſomething of their Virtue, by being drank at a little diſtance from the Spring. The Truth of which may be further confirmed by the following Obſervation, *viz.* it is found by Trials on *Spa* and many other Steel-Waters, that a quantity of it, which has ſtood about half an Hour in a Glaſs, will tinge Purple with Galls ſooner, than ſome of the ſame Water juſt taken from the Spring. A probable Argument, that the action of the open Air, on the Surface of the Water, has in ſo ſhort a time, diſpoſed the Mineral Particles to be in ſome degree diſintangled from the Water, ſo as to be tending towards uniting themſelves into larger Combinations: Which is agreeable to Monſieur *Geoffroy*'s

Obſervation, *viz.* that the Tincture with Galls will be ſlower, the more intimately the Steel is diſſolved in and blended with the other Mineral Principles of the Waters; which ſeems to be the Caſe of the Steel-Water near *Claremont*, which is ſlower in coming to its full Tincture with Galls than moſt Steel-Waters that I have obſerved. Hence we may ſee how wrong a thing it is to have the Reſervoir of Water at the Spring Head, I mean the Reſervoir under the Stone Baſons, too large, in proportion to the Quantity of Water, that flows from the Spring. A fault which I have obſerved in the opening of ſome Steel-Springs. For when the Stream is ſmall and the Reſervoir large, too great a Quantity of Water will ſtand there, ſtagnating and conſequently loſing its Virtue.

As to *Bath* Water, the tendency of it towards cooling, may of its ſelf probably cauſe a proportionable tendency of the Mineral Particles, which abound in that Water, towards a coaleſcence into Particles of a ſomewhat larger ſize: And this Coaleſcence of the Mineral Particles, which is occaſioned by the cooling of *Bath* Water, cannot probably be diſſolved again, by reducing the Water to its firſt degree of Heat; and accordingly it is found, that *Bath* Water when once cold, tho' heated again, will not have the good effect, that warm Water freſh from the Spring has: Its more ſubtile Mineral Particles being probably abſorbed by and incorporated into the calcarious matter which abounds in that Water.

Yet ſince, according to Dr. *Guidott*'s, and other Obſervations, there are found about eleven Grains and a Quarter, of Mineral Sediment in a Pound of *Bath* Water evaporated to dryneſs; and ſince the Quantity of Sediment in a Quart of *Bath* Water, after it has ſtood long, is very ſmall, ſo ſmall as to make it be diſputed, whether there be any Sediment; and ſince notwithſtanding this great Quantity of calcarious, ſaline, nitrous and ſulphureous Matter in this Water, it yet continues clear tho' long kept in Bottles, a probable Argument that its Mineral Particles are not combined in very groſs Combinations; Since, I ſay, this is the Caſe, it ſhould ſeem probable, that this Water, tho' kept for a conſiderable time in Bottles, ſhould be better than common Water; which yet ſome are of Opinion that it is not.

But when by throwing in ſome Salt or Oil of Tartar, the Salt of Tartar ſeizes on the nitrous and common Salt; then the copious calcarious Matter, being deſerted by the nitrous and other Salt, which held it ſuſpended and attenuated in the Water, immediately precipitates to the bottom, in the viſible Form of a white *Calx*. The quantity of Sediment in one Hogſhead of the Water of the King's Bath, taken from the Pump, in wet weather, and evaporated to dryneſs, was found to be, according to Dr. *Guidott*'s Obſervation, ten Ounces five Drams and half; whereof five Ounces three Drams were Grit, two Ounces one Dram and half, a blue-ſulphureous Earth or Marle; two Ounces ſeven and a half Drams Salt. Of which more than two parts in three were common Salt, the reſt Nitre. *Obſervation.* LXI, LXIV,

II.

I tryed alſo whether the tinging Virtue of Steel-Waters could be preſerved, by corking Bottles with tubulated Corks, whoſe Tubes ſtood upright above the Corks; by which means alſo, the Air could touch the Water only in the narrow Tube: This method ſucceeded very well with ſome Waters, but not with others; which I ſuſpect was owing to the Bottles not being clean enough. For when the Bottles are not perfectly clean, and free from the Tartar of Wine, or Ocry Sediment of mineral Waters which have been in them, thoſe Incruſtations ſoon attract the mineral Virtue out of Chalybeate Waters, as alſo they are well known to ſpoil Wine, Cyder or Beer, put into ſuch foul Bottles. The moſt effectual way to clean ſuch Bottles, is to boil them in a Lye of Wood-aſhes, as is done (by thoſe who are careful) in bottling Wine, *&c.* I obſerved that the Water ſubſided very ſlowly in theſe Tubes, tho' they ſtood ſome Months; a proof that good Corks imbibe very little of any Liquor that touches them.

And ſince the Virtue of Chalybeate Waters may by this means be preſerved, for ſeveral Days near the Spring Head, this method may perhaps be of ſome uſe at *Pyremont* and *Spa*. Which we have the more encouragement to attempt, becauſe a conſiderable quantity of the Virtue of theſe Waters, is long retained in Bottles, when carried to very diſtant Places: Which may perhaps be owing in the *Pyremont* Water, eſpecially to the great quantity of mineral and calcarious Matter which it contains, there being on evaporation of a Pound of it, no leſs than twenty-two Grains of dry Sediment: And accordingly it has been obſerved of ſeveral Chalybeate Waters, that their Chalybeate Virtue is detained from precipitating, for ſome Days, by ſeveral things that inſpiſſate the Waters. Yet I am rather apt to ſuſpect, that a principal reaſon why *Pyremont* and *Spa* Waters retain their Virtue longer than any of our Steel-Waters in *England* will do, may be owing to the large quantity of ſaline matter in them, for Dr. *Seip* found in the dry Sediment of *Pyremont* Water, no leſs than ſeven Grains in twenty-two to be a white bitter Salt. And in *Spa*-Water the white alkaline Salt is in the proportion of eight Grains to ten, to the reſt of the Ocry Sediment; ſo that as was above obſerved in *Bath*-Water, this proportion of ſaline matter, which is ſtrongly attracted by the Water, contributes probably towards the keeping the mineral Virtue of theſe Waters the longer ſuſpended in them. But if the mineral Virtue of *Pyremont* and *Spa*-Waters is ſuſtained longer in theſe than other Waters, by means of the little inviſible Air-Bubbles that abound in theſe Waters; then this method of Tubes, would do more harm than good, by depriving them of thoſe Air-Bubbles: Which Air Bubbles being enlarged by warmth, may be the reaſon why *Pyre-*

mont-Waters bear heating longer than other Waters, without precipitating their mineral Particles, tho' the great proportion of ſaline matter ſeems to me to be the principal cauſe.

I could wiſh therefore that ſome curious Experimenter and Obſerver would make the tryal; not with tubulated Corks, as abovementioned; becauſe it would be a difficult matter and endleſs trouble, to fit ſuch Corks in a proper manner to every Bottle; and to cut the bottom of each Cork hollow like a Cone, to prevent the aſcending Air-Bubbles from lodging there.

But in the following manner, *viz.* with a glaſs Tube which is formed at each end like a Tunnel; which Tunnels being of a ſufficient ſize to cover the outſide of the Noſe of every Bottle; to which they muſt be fixed by means of ſome proper ſoft Wax, wrapped round the Noſe of the Bottles, which are firſt to be filled with Water, before the Tube be fixed, which when fixed, muſt alſo be filled up as high as the narrow part goes, but no higher. The Diameter of the glaſs Tube which is between each Tunnel, muſt be full half an Inch; elſe if it be narrower, the Tube will be filled with the aſcending Air-Bubbles, inſtead of Water, which will defeat the uſe of it. And as the Diameter of the Tube muſt be thus large, it will be adviſeable to have it ſo much the longer, *viz.* about ſixteen or twenty Inches; that the influence of the Air on the ſurface of the Water in the Tube may be the longer before it reach to the Water in the Bottle: Beſides, the longer the Tube is, the more difficult it will be for the ſubtile ſulphureous Vapour to eſcape, which Vapour is obſerved to give a kind of vinous Taſte to *Pyremont* Waters; and is a different thing from the ſparkling Air-Bubbles, in which many are apt to think, the Virtue of theſe Waters does principally conſiſt: Which ſulphureous Vapour aſcends in ſuch quantity, that it not only ſometimes intoxicates the *Waiters*, but in a dry Conſtitution of the Air, it kills Ducks which ſwim on that Water in a ſhort time; but does not incommode them in the leaſt in a moiſt Air. Whence it has been falſely concluded that *Pyremont* Water abounds more with this ſulphureous Vapour, in dry than a moiſt Air; whereas the true Reaſon of its not killing Ducks when the Air is moiſt, is owing to the great quantity of Watry Vapour with which the ſulphureous are then diluted and blended, which much abates their noxious Quality; as I have fully proved in my *Analyſis of the Air*; ſee my *Statical Experiments* Vol. I.

Bottles filled with the Water thus prepared, would not be ſo apt to burſt, as the Dealers in thoſe Waters complain they are too apt to do in the common method, notwithſtanding they let them ſtand for ſome time open, for the elaſtick Air to fly off before they cork them; by this means, they might alſo with the more ſafety, be corked with a leſs quantity of Air under the Cork, which would contribute to the better preſerving the Water.

I am ſenſible, that thoſe who believe the Virtue of theſe Waters conſiſts chiefly in their volatile elaſtick Air, or Spirit, as it is called, will think them vapid and ſpoiled by this management. But on the other hand it is not eaſy to conceive how ſuch elaſtick Aerial Vapours ſhould enter the finer Veſſels of the Body, or if they did, they ſeem to be more likely to do harm than good: For theſe Waters which abound with ſuch elaſtick Airey Vapours, are found to diſcompoſe the Head by filling the Stomach with Wind, more than other Chalybeate-Waters do: Thoſe who are fond of drinking much Wind with their Water, need not be at the expence of buying *Pyremont* or *Spa*-Waters; 'tis eaſy to put into common Water a mixture, that will produce plenty of ſparkling Air. If therefore, on tryal, al, this method of preſerving theſe Waters ſhall be found of any uſe; it will I hope compenſate for the imagined loſs, in the want of the briſk Air, which flies off the Water in a ſparkling manner.

Several who are curious Obſervers, have found that a conſiderable number of the Bottles of *Pyrmont* Water, which they have uſed, tho' they have been very briſk and ſparkling, yet have given no manner of Tincture with Galls or green Tea; nor have they found any Benefit in drinking ſuch effœte Water. And I have my ſelf frequently obſerved the ſame thing. It would therefore be a good way to try every Bottle with Galls or green Tea, before any of it is drank. But it were unreaſonable and unjuſt to lay any blame on the *Dealers* in thoſe Waters, when in truth it ought to be imputed rather to the great difficulty there is in carrying Chalybeate Waters to very diſtant Places, with any degree of their mineral Virtue. The cooler the Weather, the more likelihood there is of ſucceſs. I ſhall be glad if the method I have here propoſed, may contribute any thing towards it.

I have found the ſize of the Bubble of Air, which has riſen from a common inverted

Pyremont Bottle of that Water heated to be $1+\frac{1}{4}$ cubick Inch, being tryed here in *England*; there would doubtleſs much more have riſen from a like quantity of freſh Water at *Pyremont*: Some of the thus generated Air was again reſorbed by the Water, in ſtanding ſome Days. And Mr. *Ed. Warkman* a Gentleman of *Leyden*, to whom a Friend of mine gave a Paper of ſome Experiments, which I deſired to have tryed on *Spa* Water, found on tryal, that there aroſe in ſeven Days, from a Flaſk of the *Geronſterre*-Water, whoſe Noſe was inverted into a Glaſs of the ſame Water, more than a cubick Inch and half of elaſtick Air. And that the Water retained its tinging Virtue with Galls very well; but that it intirely loſt that peculiar Smell and Taſte, which it has when firſt taken from the Fountain; and retains only the Taſte of the *Pohon*-Waters, but a little flatter: For which reaſon 'tis thought that it will anſwer no other end, when tranſported to diſtant places, than what the *Pohon* does much better. And Dr. *Chrouet* an antient eminent Phyſician at *Spa*, ſays in his printed Declaration, of the *Geronſterre*-Water, that its metallick Sulphur, in which its principal Virtue conſiſts, is ſo very ſubtile, that it flies away, notwithſtanding all precautions that can be uſed, in Bottling to prevent it. But it could not eſcape thro' the above mention'd inverted Glaſs Bottle; it muſt therefore be either raiſed and mixed with the elaſtick Air-Bubble, at the upper part of the Glaſs Bottle, or be reduced to a more fixed ſtate, by uniting and combining with the other Mineral Principles in the ſtagnant ſtate of the Water; which ſeems to me the more probable, for the tinging Virtue of the Water with Galls continued, notwithſtanding what was raiſed from the Water, in that large Air-Bubble. And Dr. *Seip* of *Pyremont* wrote me word, that that Water retained its tinging Virtue, notwithſtanding he had poured ſome of it, many times to and fro, to free it from its elaſtick Air, and ſubtile volatile ſulphureous Vapour. He ſays that that Water keeps the better for having Oil on it in the Neck of the Bottle.

III.

I have made alſo ſome Attempts to preſerve Chalybeate Waters with Glaſs Tubes, about ſix Inches long, which were open at one end, and had a ſmall Bubble at the other end, of ſuch a ſize that it could well enter a common Quart Bottle, which had a large Mouth. When the Bottle was filled with Water, the Tube was put into the Bottle with the Bubble uppermoſt; and the Bottle being brim-full of Water, a Cork of the beſt ſort being firſt wetted to clear it of ſmall Air-Bubbles, was preſſed hard into the Mouth of the Bottle, and tied faſt down: By which means the Air in the Glaſs Bubble was proportionably compreſſed by the Water which roſe above half way up the Bubble: The remaining ſpace in the upper part of the Glaſs Bubble, being left for ſome of the Water to aſcend into, in caſe it ſhould dilate, by any greater degree of Heat, than it had at firſt, which would otherwiſe indanger the burſting of the Bottle,

Dr. *Burton* found the tinging virtue of *Sunning-Hill* Water well preſerved by this means at *Windſor*. And Mr. *Hooker* found that *Tunbridge-Wells* Water thus preſerved at *Tunbridge* Town, which is ſix Miles diſtant, did ſometimes ſucceed very well, and gave as fine a Tincture as at the Spring Head, after ſeveral Months keeping, and ſometimes he had not the like ſucceſs; and others as well as my ſelf found the ſame uncertainty as to the Event: Which may be attributed to two Cauſes, *viz.* either the different degree of warmth or coldneſs of the Weather, when the Water was taken up: Or elſe to the different degree of cleanneſs of the Bottles, which were made uſe of; for I met with many diſappointments, before I was ſufficiently aware of the importance of having the Bottles, as perfectly clean as if they were new. For if there be any Tartarine Sediment, adhering to the bottom of them, that is very apt to draw to it the Mineral Virtue of the Water; in the ſame manner as the calculous matter of Urine will be attracted in greater quantity by a foul than by a clean Urinal, as alſo the Stones in the Kidneys or Bladder attract ſimilar Particles from the Urine.

IV.

There is another way alſo which I made uſe of, by which the Air was abſolutely ſecluded from touching the Water in the Bottles, in any the leaſt part, *viz.* I choſe ſome of the ſofteſt velvet Corks that I could procure; and thruſt five or ſix of them, into a Quart Bottle, they being firſt well wetted to clear them of adhering Air-Bubbles. Then filled the Bottles brim-full of Water, and thruſt hard into the Mouth of it, a very good Cork, tying it down firm. By this means no Air could touch the Water; and at the ſame time the Bottle was ſecured from burſting; becauſe, as the Water dilated at any time with more warmth, the ſoft yielding Corks were proportionably compreſſed, to make room: for I found that by putting ſuch Corks under Water in a Glaſs Veſſel, and placing it in a Glaſs-condenſing Engine, that on compreſſing the Air, it made the Water ſubſide in which the Corks were immerſed, by their yielding to the greater preſſure of the Water.

I have by this means ſucceeded in preſerving the Virtue of Steel-Waters, for ſix Weeks near the Spring: And ſometimes not ſo long. I was at firſt apprehenſive that the Corks might contribute, in ſome degree, to the ſpoiling of the Mineral Virtue of the Waters, they being turned black by it. But Dr. *Seip* aſſured me of the contrary, he having put an hundred new Vial Corks, into a three-pint Bottle of *Pyremont* Water, which being tried with Galls, after it ſtood a Month in his Study, it gave a very good Tincture: And Mr. *Warkman* found the ſame Event with *Spa* Water.

Thus have I given an Account of the ſeveral means which I made uſe of, for preſerving the Mineral Virtue of Steel-Waters, hoping they may all be of ſome uſe, in different Circumſtances; at leaſt to convey ſome of theſe Waters a little way. Thoſe who have not the convenience of Glaſs Tubes, may perhaps find ſome Benefit in the uſe of ſoft Corks.

As Heat is apt to ſpoil the Virtue of theſe Waters; it ſeems probable that it would be of ſome uſe, to cover the Bottles with Salt in a Baſket in very hot Weather; this might be of uſe for carrying Bottles of theſe Waters to ſmall diſtances, as from *Iſlington* to any part of *London*, *&c.*

When it is adviſeable to drink Chalybeate Waters warm, I find it is better to warm them in a Bottle, with its Noſe downwards than upwards: For I found by Trial at *Sunning-Hill* that when I put two Vials full of cold Water, into a Veſſel of the ſame Water, and warmed it; the Water in the inverted Vial gave a better Tincture, than that in the other Vial which was not inverted: And only one Draft ſhould be warmed at a time, for when warm, it ſoon grows foul and loſes its Virtue.

As the Mineral Particles of Chalybeate Waters, are doubtleſs in their moſt ſubtile and attenuated ſtate, and therefore moſt efficacious at the Fountains; ſo it will ever be beſt to drink them there: But as this cannot in many Caſes and Circumſtances be done, it is therefore a Matter of great Importance for the Benefit of Mankind, to try if any means can be found out, to convey them to diſtant Places, with a good degree of their Virtue; that is, with their fine Mineral Particles as little combined into larger ones as may be.

V.

I have hitherto given an Account of the good and bad ſucceſs, I have had, in attempting to preſerve the Virtue of Chalybeate Waters, by Mechanical Contrivances, without putting any ingredient into them. I ſhall now mention other means which I made uſe of, which proved more effectual, *viz.* by dropping in of Acid Spirits, which are frequently preſcribed by Phyſicians, to be taken with Chalybeate Waters, in ſuch Forms and Proportions as they think proper; and that often to the great Benefit of their Patients. They are alſo frequently uſed to check the too great Ferment of Wine or

Cyder, by burning Brimſtone in the Caſks, whereby they are impregnated with true Oil of Sulphur.

But as I have no Intention to intrude into the Phyſicians Province for which I am no ways qualified; ſo my preſent purpoſe is only, to give an Account of the Effects, which different numbers of Drops of theſe acid Spirits had on different Chalybeate Waters; in order thereby to find out the leaſt number of Drops, that will ſuffice to keep their Mineral Particles, in ſo attenuated a ſtate, as will prevent their precipitating to the Bottom and Sides of Veſſels: leaving it to Phyſicians to determine as to the wholeſomneſs of them, as alſo in what Caſes and Proportions ſuch acidulated Waters are to be drank.

I am obliged to Sir *Conrad Sprengell* for the following Obſervation on Steel-Waters, as alſo for ſome other Improvements and Amendments which he made on the peruſal of theſe Papers, *viz.* "Steel-Waters contain a ſubtile Acid, by which as a Medium the Iron Ore is made ſoluble and united with the Waters. Alcalies by deſtroying that ſubtile Acid, deſtroy the Bond of Union betwixt the Waters and their Ingredients. Now the Queſtion is, how

" to preſerve this vitriolick Acid, no doubt
" by an Addition of ſomething like it, and
" yet the Acid ſhould not prevail, becauſe
" then the Galls and other Aſtringents will
" give no Colour to the Waters; in the
" manner as any inky Writing may be ef-
" faced by Lemon Juice, Spirit of Vitriol,
" *&c.* Hence no black Tincture can be
" produced with Galls, but when the Iron
" is predominant. Green Vitriol makes Ink
" only by its Iron, hence the Colours in Steel-
" Waters, and from no other parts of the
" Vitriol, for blue Vitriol makes no Ink.
" Oil and Spirit of Vitriol change Iron into
" Vitriol; but with this Difference that Oil
" put upon Filings of Iron, changes them
" into white, and Spirit into green Vitriol.
" Vitriol is a Sal Medium form'd of an acid
" and ferrugineous Subſtance which makes
" green Vitriol, but the blue is compounded
" of Copper."

As the acid Spirits here made uſe of, were not always the ſame, but bought at different Places, by my ſelf and others, who made Experiments with them; ſo thoſe who ſhall think fit to repeat any of theſe Experiments hereafter, may perhaps find ſome little variation, of a Drop or ſo, of the quantity that will do. What I here often mention as Oil of Sulphur, and which was bought for ſuch; was not probably true Oil of Sulphur, but what is commonly ſold for ſuch, *viz.* ſometimes Oil of Vitriol mixed with Water, or ſometimes Spirit of Vitriol, it being difficult to procure true Oil of Sulphur.

Mr. *Boyle Godfrey, the Chymiſt* in his *Miſcellaneous Experiments and Obſervations*, p. 136. cautions againſt the uſe of Oil of Vitriol, as being a more metallick Acid than the true Spirit of Vitriol: But as what is commonly ſold for Spirit of Vitriol, is, he ſays, Oil of Vitriol mixed with Water; and that if Oil of Vitriol is ever uſed, one third leſs of it, than of the Spirit of Vitriol will do; hence we ſee the great uncertainty there is, as to the Strength of theſe acid Spirits.

Gas Sulphuris might be uſed for this purpoſe, which is Water ſtrongly impregnated with the Fumes of burning Brimſtone, in a large Receiver; but ſome look on this as a poor ſour Water, and as the quantity of Spirit of Sulphur, in each Preparation of it, would probably be very different; accordingly different quantities of the *Gas*, would alſo be requiſite, in order to adjuſt the due proportion that would ſuffice to preſerve the Virtue of Steel-Water with it.

I was obliged to Mr. *Hooker* of *Tunbridge* for putting me on the reſearch, to find out the ſmalleſt number of Drops of Oil of Sulphur, that would effectually preſerve the mineral Particles of Chalybeate Waters from precipitating; in which he had made ſome progreſs, and recommended to me the farther purſuit of it. For, as he obſerves, if ſome of theſe Waters ſhall require ſo many of theſe acid Drops, as ſhall be thought to make Water too acid to be drank in any quantity; that Acidity may eaſily be wholly taken away, by dropping in, a little time before the Water is drank, a few Drops of Oil of Tartar, which by ſeizing on and combining with the acid Spirit, will form a wholeſome neutral Salt. And the Mineral Particles of the Water, being thereby diſſeized of the acid Spirit, are ſet at liberty, to act almoſt as effectually, as before the acid Spirit was dropped in, as appears by the fine Tincture it will then give with Galls, if the Galls are firſt put in.

July 22d, Mr. *Hooker* ſet two *Florence* Flaſks full of *Tunbridge-Wells* Water on a Gravel Walk in very hot Sun-ſhine, from ten in the Morning till ſeven in the Evening, having firſt put three Drops of Oil of Sulphur into one of the Flaſks. At three in the Afternoon, he found the Water heated to that degree, that he could ſcarce bear to hold the Flaſks in his Hands: The Air-Bubbles were continually riſing. The Water without any acid Spirit in it, was turbid, and had depoſited much Ocre, and gave no tincture with Galls. The other with the Oil of Sulphur was tranſparent, and had a mineral ferrugineous Smell: Upon putting one eighth of a Grain of Galls to a Pint of it, it very ſlowly changed to a pale Purple; but on dropping in one Drop of Oil of Tartar, it inſtantly gave as deep a colour as freſh Water at the Spring, and with one Drop more, a deeper Purple than he ever ſaw in freſh Water with the ſame quantity of Galls.

In order to find out the leaſt number of Drops of acid Spirit that would preſerve unprecipitated the mineral Particles of this Water, I deſired the Reverend Mr. *Wilſon* Rector of *Walbrook* Church in *London*, to provide ſix very clean Quart Bottles; into which as ſoon as filled at *Tunbridge-Wells*, he dropped into Numb. 1. two drops of Oil of Sulphur, Numb. 2. three Drops. Numb. 3. four Drops, Numb. 4. five Drops. Numb. 5. ſix Drops. And Numb. 6. eight Drops. After theſe Bottles being corked, had ſtood an

Hour, to give time for the acid Spirit to diffuſe it ſelf uniformly thro' the whole Water; he then filled ſix equally ſized Vials, with Water out of each Quart Bottle, and put equal quantities of powdered Gall into each Vial, and corked them: After ſtanding an Hour, Number 1. was tinged of a light blue Colour; but none of the other five were in the leaſt tinged.

Hence we ſee that three Drops of Oil of Sulphur in Numb. 2. ſo effectually ſeize on and lock up the mineral Particles of this Water, that they cannot be ſo acted on by Galls as to produce any Tincture; But when a little Oil of Tartar is added, which ſeizes on the acid Spirit, ſo as to cauſe it to let go its hold of the mineral Particles, which it kept attenuated and ſuſpended, then they are at liberty to tinge with Galls, or to unite into ſo groſs Combinations, as cauſes them to precipitate in the form of Ocre.

Theſe Experiments were made the beginning of *Auguſt*, and the ſeventh of *Auguſt* in the next Year, the Weather Temperate, I procured by the favour of a Friend, three wine Quarts of *Tunbridge-Wells* Water. The Bottle Numb. 1. had three Drops of Oil of Sulphur. Numb. 2. had four Drops, And Numb. 3. had five Drops. Theſe I received at *Teddington*, *Auguſt* the fifteenth: When Numb. 1. gave with Galls, only a ſtrong blue Tincture, which was heightened with Oil of Tartar, to a reddiſh Tincture; it had a manifeſt Sediment at the bottom, but no cloudy Flocks or Thrumbs; hence three Drops of Oil of Sulphur are not ſufficient to preſerve it good for ſo ſhort a time; notwithſtanding that number of Drops was found ſufficient, ſo effectually to lock up the mineral Particles, as totally to extinguiſh the tinging Virtue of this Water with Galls.

Neither will four Drops be ſufficient to keep it good long; for tho' *Auguſt* the 15*th* it had little or no Sediment, and gave a ſtronger blue Tincture than Numb. 1. which was heightened with Oil of Tartar to a good reddiſh Purple, at which time I poured off a Pint of it, the better to preſerve it; yet *Auguſt* the twenty-firſt, there was ſome Sediment in the Pint, and it gave a ſomewhat weaker Tincture, than it did *Auguſt* the fifteenth. And *Auguſt* the thirtieth there was much more Sediment, and alſo a proportionably weaker Tincture.

But the Water of the Bottle Numb. 3. which had five acid Drops in it, gave *Auguſt* the fifteenth a much ſtronger blue Tincture with Galls than Numb. 2. which was heightened with Oil of Tartar, to ſo deep a reddiſh Purple, that was hardly tranſparent. *Auguſt* the twenty-firſt the remainder of the Bottle gave alſo a deep Tincture. A Pint of this bottled, which was filled from it *Auguſt* the fifteenth had no Sediment *Auguſt* the thirtieth, and gave as ſtrong a Purple as at firſt; it gave alſo a good Tincture *September* the twenty-fifth; And tho' this Pint ſtood not full from that time to *January* the eleventh, yet there was no Sediment, and it gave a blue with Galls, and with the addition of Oil of Tartar a fine reddiſh Tincture; which redneſs is increaſed by the Salt in the Oil of Tartar, in the ſame manner as the Salt of *Aquafortis* heightens the colour of Cochineel in the ſcarlet Dye, and as Nitre alſo heightens the redneſs of Blood. Hence we ſee that five Drops of Oil of Sulphur to a Quart, are ſufficient to preſerve the Virtue of this Water long. But as this number of Drops make it conſiderably acidulated, tho' not ſo much as to be diſagreeable, yet, if more than ſhould be, in drinking any conſiderable quantity of this Water, this Acidity may be abated by adding any proportion of fair Water; or may be wholly taken away, by two or three Drops of Oil of Tartar.

It is obſervable that in keeping this Water ſo long as to *January*, its Acidity was ſo much abated that it was ſcarcely to be taſted.

It ſeems probable, that if tubulated Corks were uſed with Bottles of this thus acidulated Water, they would not only contribute to preſerve the Water the better; but there might alſo be this further convenience, that the Virtue of ſome of theſe Waters, might alſo be thus preſerved with fewer Drops. For I often obſerved, on the *Cobham*-Water thus acidulated with the feweſt Drops that would do; that it kept much longer and better when the Bottles were full, than when, by being but half full, a broader ſurface of the Water was expoſed to the influence of the Air.

Whereas *Tunbridge-Wells* Water required three Drops of Oil of Sulphur, totally to extinguiſh its tinging Virtue with Galls. One Drop of that acid Spirit will have the ſame effect on the abovementioned Steel-Water of *Cobham* near *Claremont* in *Surrey*: And three Drops will as effectually preſerve the mineral Virtue of that Water for two or three Months, when carried to diſtant Places to be drank, as that of *Tunbridge* is preſerved with five Drops. This difference ſeems to be principally owing to the different quantities of Chalybeate, and other calcarious matter which theſe Waters contain For *Bath* Water, which is found to contain, on evaporation to dryneſs, eleven and a quarter Grains weight of ſaline, nitrous, ſulphureous, and principally calcarious matter to a Pint; by abſorbing much of the acid Spirit of Sulphur, requires eight Drops of Oil of Sulphur to extinguiſh its tinging quality with Galls.

And even this number of Drops does not make it ſenſibly acid, after ſtanding ſome time, tho' ſomewhat harſher; the Acid being abſorbed by the great quantity of calcarious matter: And a fewer number of Drops as four or five, are not in the leaſt to be perceived, after a few Days. I have alſo obſerved of ſeveral other Chalybeate Waters, which have had no more than an agreeable degree of acidity given them, that it has in a good meaſure gone off after ſome Weeks ſtanding.

October the fifth, I received at *Teddington*, ſome Bottles of *Bath* Water, which had ſeverally in them from one to eight Drops of Oil of Sulphur, when I put powdered Galls into Vials full of the Water of each Bottle. They all gave a bluſh, except that with one Drop, and another with no Drop in it, both which were not ſenſibly altered in Colour.

The Bluſh of the other ſeven was ſtronger and ſtronger, in proportion to the number of Drops of Oil of Sulphur, which was in the reſpective Water. But it did not exhibit this Bluſh ſeven Days after, which was fourteen Days from the time the Bottles were filled at *Bath.*

And whereas ſuch acid Drops do effectually prevent the precipitation of the mineral Particles, which in other Steel Waters are apt to precipitate; I could perceive no ſenſible difference at the bottom of thoſe Bottles, which had eight Drops in them, and thoſe which had none: Whence it is probable that this Water depoſites no Sediment, unleſs by ſtanding very long. The ſmall quantity of Sulphur which is in it, ſeems to be prevented from precipitating, by its uniting its ſelf with the great quantity of calcarious matter in that Water; as is probable from Dr. *Guidott*'s Experiments and Obſervations.

The Chalybeate Water near the Corn-Mill at *Bramſhott* in *Hampſhire*, has its tinging Virtue extinguiſhed with three Drops. The Chalybeate Water at *Coſſe*'s-Mill near *Midhurſt*, *Suſſex*, requires five Drops.

Sunning-Hill Water has never four Grains of dry Reſiduum in a Pound; and with four

Drops of Oil of Vitriol to a quart, retained its Virtue of tinging with Galls, for fifty Days at the Spring-Head. This Sediment does not melt in ſtanding many Days, an Argument that there is little ſaline in it.

But the Sediment of the Steel-Water near Sir *William Abdy*'s in the Pariſh of *Chobham* in *Surrey*, which is near equal in quantity with that of *Sunning-Hill*, riſes in drying, in broad Alum-like Bliſters; which had a mild ſaline Taſte. Native Nitre is known to be alkaline and to riſe in Bliſters like Alum, and has no ſign of acidity before it is expoſed to the Fire, and has always a mixture of common Salt. Moſt Chalybeate Waters have ſome nitrous Salt, and thoſe which have moſt of it, are eſteemed the beſt.

I found on two different Trials, little more than a Grain of yellow Ocry Sediment, in a Pound Avoirdupoiſe of *Cobham* Steel-Water, when evaporated to dryneſs; nor did it melt in ſtanding many Days, a ſign that there is little ſaline in it; yet this Water, as moſt Spring Waters do, gives white Clouds with a ſolution of Silver; a ſign of ſome Salt.

This Water ſeems to have little elſe in it beſides the Chalybeate Matter. Its great purity ſeems to be owing to its ſpringing out of a pure whitiſh Sand, from a Hill which is all Gravel to its ſurface; in which circumſtances the Springs of pureſt Water are obſerved to riſe; four inſtances of which I have given, in my *Statical Eſſays*, Vol. II. p. 240, *&c.*

Mr. *Hooker*, having at *Tunbridge* Town, cut two clean *Florence* Flaſks to a wide Orifice, and then weighed them, he poured into each of them a Pound Avoirdupoiſe of *Tunbridge* mineral Water: which being very carefully and ſlowly evaporated away in ten Hours, he weighed the Flaſks the next morning, and found they were increaſed in weight two Grains and a quarter; which being therefore the weight of the Sediment in that quantity of Water, ſhows it to be a very pure Water: This was done the 26*th* of *January* in a very rainy Seaſon; and yet the Water gave as good a Tincture with Galls as in a dryer Seaſon. This Sediment did not melt into a Liquor, but was ſoft in ſtanding ſome Days in the inverted Flaſks, an Argument that there is ſome Degree of Salt in it; which might alſo probably be diſcovered, by dropping a few Drops of Solution of Silver in that

Water. The Reverend Mr. *Wilſon* found but a Grain and half of Sediment, on evaporating away a like Quantity of it, at *Tunbridge-Wells* in the beginning of *Auguſt*.

Philippus Ludovicus de Preſſeux, in his *Diſſertatio Medica Inauguralis* 1736, ſays that he procured by evaporation to dryneſs, from ſeven Pounds of the *Geronſterre* Water at *Spa*, eight Grains of an Alkaline Salt, and ten Grains of Ocre. If this be the whole Sediment in ſo large a quantity of this Water, then its mineral Virtue might probably be preſerved from precipitating, with very few Drops of acid Spirit.

And that the greater or leſſer quantity of Oil of Sulphur, requiſite to extinguiſh the tinging Virtue of any Steel-Water, depends on the proportion of the quantity and quality of the calcarious or other mineral matter in the Water, is further evident from hence, *viz.* That upon having put a little powdered Whiting into the *Cobham* Water, it then required no leſs than eight Drops of Oil of Sulphur, to extinguiſh its tinging Virtue: And then gave a very deep untranſparent Tincture.

Hence alſo we may ſee, that the ſtrength and goodneſs of a Chalybeate Water, cannot be judged of by the deepneſs of its Tincture with Galls, as ſome are apt to imagine. Thus the Water at *Coffe's*-Mill gives a deeper Tincture, than any I ever ſaw, but withal requires more Oil of Sulphur, than the very pure *Cobham* Water; *viz.* Five Drops to extinguiſh its tinging Virtue; whence it is probable that it would have more Sediment on evaporation, which I omitted doing.

Dr. *Nesbit* found that *Iſlington* Water required nine or ten Drops of Oil of Sulphur to extinguiſh its tinging Virtue, a probable Argument that it has a good deal of Sediment on evaporation.

And as *Pyremont* Water has twenty two Grains of Sediment, in a Pound of it evaporated to dryneſs; and the Water of the *Caroline* Baths in *Germany* no leſs than thirty Grains; they would probably require many Drops of this acid Spirit to extinguiſh their tinging Virtue. And it is obſervable both in *Pyremont* and *Bath* Waters, that the Tincture of them with Galls ſoon precipitates much Sediment, the aſtringent quality of the Galls combining their mineral Particles into ſo large a ſize, as cauſes them to precipitate; whereas the Tinctures of purer Steel-Waters ſtand very long without precipitating.

It ſeems therefore reaſonable, in order to judge of the comparative ſtrength of Chalybeate Waters, not only to compare the different ſtrength of their ſeveral Tinctures, but alſo their reſpective quantity of Sediment on evaporation to dryneſs. These Circumſtances added to what may be learnt, by Experience of the effects they have on thoſe who drink them, may ſerve the better to judge of their different ſtrengths.

There is another ingenious method, to find the comparative ſtrength of Chalybeate Waters, propoſed by Mr. *Alexander Monro*, *Profeſſor of Anatomy* in the *Univerſity* of *Edenburgh*, which is mentioned in the medical Eſſays and Obſervations, publiſhed by a Society in *Edenburgh.* Vol. III. 1735. *viz.*

" He obſerves that Writers on this ſub-
" ject have contented themſelves with telling
" us, that ſuch Waters ſtrike red, purple,
" violet or black Colours, when Galls or
" ſuch other Aſtringents are mixed with them;
" and ſome have ſaid that the deepeſt Colour
" ſhews the greateſt proportion of Steel.

" To ſatisfy himſelf of the truth of this,
" he diſſolved artificial *Sal Martis*, in a ſmall
" quantity of Fountain Water; then drop-
" ping few or more Drops of the Solution, in-

“to a given quantity of common Water, he found that by the mixture of the Tincture of Galls, he could form all the different Colours mentioned; the larger quantity of the Solution always requiring the greater number of the Drops of the Tincture to bring it to all the Colour it would take; and that being as conſtantly deeper than the others, where fewer Drops of each had been employed.

“*Sal Martis* being made with four Ounces of Spirit of Wine, to two Ounces of Oil of Vitriol, kept together in an Iron Pan till they ſhoot into Cryſtals the proportion of Steel, in the artificial Salt or Vitriol of Iron, is very little more than one third part. One hundred and forty two Drops of the Solution of *Sal Martis* in common Water, weighed two Drams, therefore every ſuch Drop contained $\frac{1}{25}$ of a Grain of Salt, or $\frac{1}{75}$ of a Grain of Steel.

“Let the Glaſſes be nearly of the ſame ſize and thickneſs; to make a compariſon then of any Chalybeate Water with this Solution, into a determinate quantity of ſuch Water, pour Drop after Drop of a ſtrong clear Tincture of Galls, allowing a ſufficient time between each Drop, for its having its full effect,

" fect, till it is obſerved, that the addition of " more Tincture makes no change in the " colour of the Water; And to make ſure " of the number of Drops of the Tincture " that are requiſite, let the Experiment be re" peated ſeveral times.

" Then having the ſame quantity of com" mon Water in a like Glaſs, drop into it " the above diſcovered number of Drops of " the ſame Tincture of Galls, and mix them " well; after which in the ſame cautious " manner, drop in the Solution Drop by Drop, " till their Colour is the ſame, with that of " the mineral Water.

" When once the quantity of Solution, e" qual to the Contents of the *Spa* is known, " pour a due proportion of it, into common " Water; and let ſeveral People examine, " whether the Taſte of it is not the ſame, " with what the mineral Water has. He " has made, he ſays, Fountain Water ſo like " to ſeveral Chalybeate Waters, that none " could diſtinguiſh them."

The purer the Watry Vehicle of any Steel-Water is, doubtleſs ſo much the better, provided there be enough of the Chalybeate Virtue. I have not obſerved this Steel-Water of *Cobham* to be the weaker for much Rain. And

I am credibly inform'd that an eminent Phyſician, who had made many Obſervations on *Tunbridge* Waters, thought them ſtronger in wet than dry Weather; which may be occaſioned by the Waters paſſing thro' ſome Chalybeate *Strata* in wet Weather, which they do not riſe to in dry Weather.

Some who have come directly from drinking the *Tunbridge* Waters to thoſe near *Claremont*, thought the former conſiderably the ſtronger. Yet ſeveral who have drank theſe, during the few Years they have been opened, have found much Benefit by them. Half a Pint of them, has in *January* given me a fine glowing warmth all over; on the motion of trotting my Horſe ſoon after, as alſo ſeveral other Times on walking, not ſlow. And they have been found to heat ſome Conſtitutions too much. There is doubtleſs a great difference in the Qualities and Strength of mineral Waters, for ſome of them are more Chalybeate than others: Some approach nearer to Vitriol, and many of them have much nitrous Salt mixed with them; whence the great difference of theſe Waters.

And as there are doubtleſs a great variety of Degrees of Strength, among the many different Steel-Springs; ſome of which are, as I have heard, abſolutely too ſtrong to be drank; and others of various different degrees of ſtrength; ſo are there likewiſe variety of Caſes in our Conſtitutions, which require very different degrees of ſtrength, in the Steel-Waters which are drank. Of which, Phyſicians are the proper and beſt Judges.

I cannot think, that the number of theſe ſalutary Springs is confined only to three or four, of the innumerable Many that kind Providence has bleſſed us with. But where there is a *Beſt*, Mankind are apt by a Foible obſervable in this as well as many other inſtances in Life, to ſlight all others as good for nothing.

I have my ſelf found all the Benefit from this Water, that I think my Conſtitution is capable of, from any *Regimen* whatſoever.

I ſhall here inſert a Letter on this Subject, which Dr. *Jurin* favoured me with, while theſe Papers were printing, *viz.*

REVEREND SIR,

"HAD I either known ſooner of your "Deſign, or been a little more at "Leiſure ſince I was appris'd of it, I ſhould "readily have communicated to you ſuch "Obſervations of mine upon Chalybeate Wa-"ters, as might have been of any ſervice.

"But I am now ſo ſtraitned for time, that "I ſhall ſend you nothing more than what "relates immediately to the Subject of thoſe "Papers you gave me the peruſal of.

"I have often obſerved, as you have done, "that when the tinging quality of *Tunbridge*, or other Chalybeate Waters, has "been ſuſpended by putting a little of an "acid Spirit into them, their tinge has been "immediately reſtored upon the addition of "*Sal Tartari*, or any like Alkalious Salt. But "then the Tinge has been ſo different from "that bright blewiſh purple, that ariſes from "the Waters in their natural ſtate upon "putting in Galls, green Thea, or any of "the like aſtringent Subſtances, being rather of a foul, dark reddiſh purple, than "a bright blewiſh one; That I have never "ventur'd to recommend ſuch a Compoſition "of the natural Water, the Acid and Alkali "join'd together, to be drunk in the room "of the Waters alone; ſuch a manifeſt difference in their tinging qualities giving "reaſon to ſuſpect that their effects upon a "human Body might alſo be very different. "However, if any one ſhould think proper "to recommend, or to drink them in the "manner you propoſe, as thoſe two Salts

“ added together will compoſe a neutral Salt, “ I ſhall not condemn the Practice, this be- “ ing a Matter, which Experience alone can “ juſtly decide.

“ But when the Acid alone is propoſed “ to be added to the Waters, the Caſe is “ greatly different. There are many diſ- “ eaſes, in which an Acid is directed by “ Phyſicians, to be taken with Chalybeate “ Waters, either as an addition to their Ef- “ ficacy, or to make them paſs off more rea- “ dily by Urine. And the quantity of A- “ cid Spirit directed to be taken in a ſingle “ Glaſs of Water, is generally more than “ what will ſuffice to preſerve a Quart of “ them almoſt for any length of time, and “ in carriage to any diſtance.

“ In this Caſe therefore we need not be “ ſollicitous about finding the leaſt quanti- “ ty of Acid that will preſerve the Wa- “ ter, which, as you obſerve, is extremely “ difficult, by reaſon of the different Strength “ of thoſe Acid Spirits which go under the “ ſame Denomination; but ſuch a quantity “ of Acid may be put into the Bottle be- “ fore it be fill’d, as for inſtance, 20 or 30 “ Drops of *Elixir Vitrioli Mynſichti*, as will “ be ſufficient to keep the Water clear, and

“ not be too much for the Patient to take. After this manner I have for many Years directed the *Iſlington* Waters to be taken by ſuch Patients, as could not conveniently drink them at the Well, particularly the poor People in Mr. *Guy*'s Hoſpital, for whoſe uſe I obtained leave of the Proprietor of the Well to fill as many Bottles as I had occaſion for, which I ſent for once or twice a Week, and they conſtantly kept good from one time of ſending to the next; though, without the Acid, thoſe Waters fill'd in the Morning and brought to Town, will be foul in an Hour or two, and good for nothing.

“ Among the Diſeaſes in which the Chalybeate Waters thus acidulated are highly beneficial, I cannot, for publick good, forbear mentioning that obſtinate Diſtemper the Diabetes, in which they ſucceed to admiration, when uſed for common Drink to about three Pints or two Quarts a day. They take off the Thirſt, abate the feveriſh Heat, and after a few days the Urine begins to return to its natural quantity, ſmell and taſte, though for two or three days, upon firſt drinking them, the quantity of Urine will ſomething in-

“ creaſe, as might naturally be expected from
“ ſo diuretick a Liquor before its aſtringency
“ has begun to take place. But before the
“ Patient enters upon this courſe he ought to
“ be gently purged with *Epſom* or *Stre-*
“ *tham* Water, with the addition of *Man-*
“ *na* and *Sal Mirabile Glauberi*, two or three
“ times at ſuch intervals as his weakneſs may
“ require.

I am,

Sir,

Auſtin-Fryars, *Your moſt Obedient*,
March 5, 1738-9. *Humble Servant*,

JAMES JURIN.

To conclude, we are not to depend wholly on natural Cauſes, as if the Mineral Waters, which Nature has produced in Plenty and Profuſion every where, would by their mere natural Efficacy cure us. We muſt alſo earneſtly apply our ſelves to the great Author and Fountain of Life, *For Man doth not live by Bread only, but by every Word that proceedeth out of the Mouth of the Lord doth Man live*, *Deut*. viii. 3. Excellent is the Advice of the Son of *Syrach*; *Honour a Phyſician with the Honour due unto him, for the uſes which you may have of him; for the Lord hath*

hath created him; the Lord hath created Medicines out of the Earth, and he that is wiſe will not abhor them, and with ſuch doth he heal Men, and taketh away their Pains. My Son, ſays he, *in thy Sickneſs be not negligent, but pray unto the Lord, and he will make thee whole. Leave off from Sin, and order thy Hands aright, and cleanſe thy Heart from all Wickedneſs; give a ſweet Savor and Memorial of fine Flower; then give place to the Phyſician. There is a time when in their hands there is good Succeſs; for they alſo ſhall pray unto the Lord, that he would proſper that which they give for Eaſe and Remedy to prolong Life. Ecclus.* xxxviii. 1, &c.

A

PROPOSAL

FOR

Cleanſing away Mud, &c.

WHERE

Waters have a Stream or Current.

A
PROPOSAL
FOR
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IT is well known that foul Muddy Waters carry along with them a conſiderable quantity of Mud, &c. which they are apt to depoſite in great quantities, eſpecially in places, where by reaſon of the frequent return of Tides, it has more time to depoſite its Sediment; by reaſon of its ſometimes ſtagnant, ſometimes ſlow and contrary Motion; as in the Mouths of Rivers, that are not rapid, in Harbours, and Reſervoirs, which are filled by the Tides.

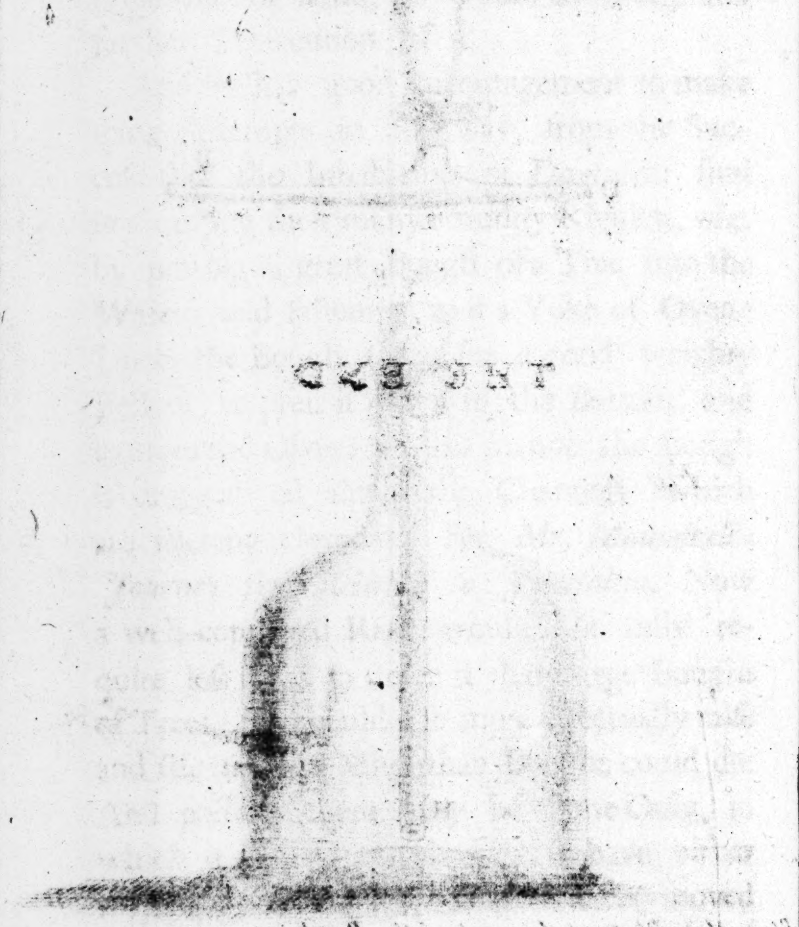
Now, if Water can by any means be made conſiderably more Muddy, in flowing out of, than into ſuch places; thoſe places muſt conſequently be gradually cleanſed of ſome of their Mud, in proportion to the greater degree of muddineſs of the Water when they flow out, than when they flow in.

And this I think may be effected in a good meaſure by the following Means, *viz.* by keeping the Mud well ſtirred, while the Stream is flowing out of the place; by means of large Rakes, linked at the ends to each other, and drawn by Horſes: Which Rakes muſt have one, two, or three Rows of Teeth, nearer or further off from each other, according to the different degree of ſtiffneſs or ſoftneſs of the Mud. And if theſe Teeth ſtand as high out, on the upper as on the lower Side of the Rakes; then when the Horſes turn to go back along the ſame Stream, the Rakes being thereby turned over, the Teeth which were uppermoſt, being then become the loweſt, will take place and ſtir up the Mud.

And theſe Rakes may be drawn, either farther from or nearer to the Shores, as ſhall be required, by various means, *viz.* By the Horſes on either ſide going for ſome ſpace, before or behind the others, or when the Horſes can only go on one ſide; by having them fixed to different Ropes of different lengths, as occaſion ſhall require. And ſometimes by fixing, either before or behind, or both before and behind, as occaſion ſhall require, broad pieces of Wood edgewiſe, which by running obliquely into the Mud, might turn the Rakes, in the ſame manner as Rudders do Ships; whereby their progreſſive Motions would be, not according, to the direction of the drawing Rope, but in the deſired courſe.

By theſe and the like means, great quantities of Mud might be ſtirred up, and carried off by the Water; and that, without any great Expence: conſidering the Advantage, it might in many caſes be of, in cleanſing off of Mud.

Trials might at leaſt be made, in ſome of the more commodious Places for the purpoſe; whence a better Judgment might be made, as to the probability of ſucceſs. Neither ſhould we be diſcouraged, if Matters do not at firſt anſwer our Expectation: It is from repeated Trials and Obſervations, that we are to hope to make ſucceſsful Improvements, in new Attempts; which are often baffled and laughed out of countenance, by incompetent Judges; who fancy they ſhow their deep Judgment and Penetration, in ſlighting and rejecting Attempts, which at firſt may prove unſucceſsful: But which an unwearied Diligence and Perſeverance might



Water-Wheels, fixed in ſteddily-anchored or moored Barges, or elſewhere as occaſion may require.

I have here only given a general Hint, which may poſſibly be farther improved, by ſome of the many ingenious Maſters in Mechanicks, with which this Age abounds.

THE END.

G.R. III
BRITISH MUSEUM

A GENERAL INDEX OF The Matters contained in this Book.

The Numeral Letters denote the PREFACE.
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